THIRD AMERICAN EDITION.

OF

Nicholson's

BRITISH ENCYCLOPEDIA

or Dictionary of

ARTS & SCIENCES

illustrated by upwards of 180 elegant Engravings.

PHILADELPHIA.

Published by Mitchell, Ames & White.

W. Brown Printer.

1819

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ARTS AND SCIENCES.

COMPRISING

AN ACCURATE AND POPULAR VIEW

OF THE PRESENT

IMPROVED STATE OF HUMAN KNOWLEDGE.

BY WILLIAM NICHOLSON,

Author and Proprietor of the Philosophical Journal, and various other Chemical, Philosophical, and Mathematical Works.

ILLUSTRATED WITH

UPWARDS OF 180 ELEGANT ENGRAVINGS.

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THE

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IRON-FOUNDERY.

IRON-FOUNDERY, the art of casting iron, and forming moulds, into which it is poured when in a fluid state.

The moulds are commonly made in sand, held in wooden frames, (fig. 3 and 4, Plate Iron-foundery.) Two of these frames, A B, (fig. 4.) are called a pair of flasks, and fit together by pins, *a a*, in one flask, entering eyes, *b b*, in the other. A wooden pattern of whatever is to be cast must first be made, exactly of the same dimensions as the article required. For an example, we have chosen to describe the manner of casting a roller, such as is used for the wheels of small waggons, the rolls of windmill heads, &c. The pattern is shown in fig. 5, 6, and 7: fig. 5 is a plan, fig. 6 a section, and in fig. 7 it is shewn edgeways. This pattern is exactly similar to the wheel which is to be cast, except that, in place of the hole through the centre of the wheel, a pin, *m*, is stuck on, projecting from each side in the same place that the holes will be: the use of these pins will be shown hereafter. The lower flask, A, (fig. 4.) is placed on a board laid on the ground; it is then filled with sand, and rammed down, first with the rammer, (fig. 9) and afterwards with fig. 10, which is broader, and smooths the work. The workman then with the trowel, (fig. 8) digs out a hole in the sand, and presses the pattern into it, the flat surface horizontal, and fills the sand in round the pattern, until it is exactly half buried; he then takes out the pattern, and if there are any holes in the under part, where the sand is not filled round close to the pattern, he puts in a small quantity of sand, and presses the pattern down again, until a perfect impression of it is left in the sand, as in fig. 1. He now returns the pattern, and sprinkles some dry sand, which has been burnt in the furnace, over the pattern and flask, and then places the upper flask, B, (fig. 4) upon it: two small sticks are placed upon the pattern, and the sand filled in round them; the sand is rammed down by the rammers (fig. 9 and 10), and the two sticks drawn out, leaving holes, *l l*, (fig. 2) through the sand in the upper flask.—The workman now takes off the upper flask, B, by its two handles, leaving the pattern in the lower flask; the burnt sand causes the two flasks to separate exactly at the joining of the flasks: the upper flask is now completely finished, the holes, *l l*, made by drawing out the sticks, being left to pour in the metal, and the pattern leaving a perfect print of its upper half in the flask. The next operation is lifting the pattern out of the lower flask, before which the workman wets the sand around the pattern, that it may adhere together, and not be broken by lifting the pattern. The two pins projecting from the wheel where the hole is to be, leave their impressions in the sand, forming two holes, *e f* (fig. 2) one in each flask. These holes receive the ends of a core, which is exactly the shape and size of the hole required in the wheel: the core is formed of a mixture of plaster of Paris and brick dust, and is made just the length and size of the pins in the pattern, that it

may be truly in the centre of the wheel. Fig. 2. is a section of the two flasks when put together; but the core is not put in: *l l* are the holes for the metal, and *g h i k* the hollow cavity to receive it.

The iron is melted in a furnace, and brought from it in a ladle (fig. 11) which has three handles, and is carried by two men, the forked handle, M, giving a purchase to the man holding it, to turn over the ladle to deliver its contents. If the work is very small, the metal is conveyed to the flasks in common ladles.

The more intricate cases of iron-foundery, as the casting of cylinders for steam engines, crooked pipes with various passages, &c. are cast in moulds formed of loam or clay, and are done nearly in the same manner as the moulding of plaster casts from busts, &c. but our limits will not allow us to describe these curious branches of the founder's art.

IRONY, in rhetoric, is when a person speaks contrary to his thoughts, in order to add force to his discourse.

IRRATIONAL, an appellation given to surd numbers and quantities. See SURD.

IRREDUCIBLE *case*, in algebra, is used for that case of cubic equations, where the root, according to Cardan's rule, appears under an impossible or imaginary form, and yet is real. Thus, in the equation, $x^3 - 90\,x - 100 = 0$, the root, according to Cardan's rule, will be $x = \sqrt[3]{50 + \sqrt{-24500}} + \sqrt[3]{50 - \sqrt{-24500}}$, which is an impossible expression, and yet one root is equal to 10; and the other two roots of the equation are also real. Algebraists, for two centuries, have in vain endeavoured to resolve this case, and bring it under a real form; and the question is not less famous among them than the squaring of the circle is among geometers. See EQUATION.

It is to be observed, that as, in some other cases of cubic equations, the value of the root, though rational, is found under an irrational or surd form; because the root in this case is compounded of two equal surds with contrary signs, which destroy each other; as if $x = 5 + \sqrt{5} + 5 - \sqrt{5}$; then $x = 10$; in like manner, in the *irreducible* case, when the root is rational, there are two equal imaginary quantities, with contrary signs, joined to real quantities; so that the imaginary quantities destroy each other. Thus the expression:

$\sqrt[3]{50 + \sqrt{-24500}} = 5 + \sqrt{-5}$; and $\sqrt[3]{50 - \sqrt{-24500}} = 5 - \sqrt{-5}$. But $5 + \sqrt{-5} + 5 - \sqrt{-5} = 10 = x$, the root of the proposed equation.

Dr. Wallis seems to have intended to show, that there is no case of cubic equations irreducible, or impracticable, as he calls it, notwithstanding the common opinion to the contrary.

Thus in the equation $r^3 - 63\,r = 162$, where the value of the root, according to Cardan's rule, is, $r = \sqrt[3]{81 + \sqrt{-2700}} + \sqrt[3]{81 - \sqrt{-2700}}$, the doctor says, that the cubic root of $81 + \sqrt{-2700}$, may be extracted by another impossible binomial, *viz.* by $\frac{9}{2} + \frac{1}{2}\sqrt{-}$; and in the same manner, that the cubic root of $81 - \sqrt{-2700}$ may be extracted, and is equal to $\frac{9}{2} - \frac{1}{2}\sqrt{-3}$; from whence he infers, that $\frac{9}{2} +$ is $\frac{1}{2}\sqrt{-3} + \frac{9}{2} - \frac{1}{2}\sqrt{-3} = 9$, is one of the roots of the equation proposed. And this is true: but those who will consult his algebra, p. 190, 191, will find that the rule he gives is nothing but a trial, both in determining that part of the root which is without a radical sign, and that part which is within: and if the original equation had been such as to have its roots irrational, his trial would never have succeeded. Besides, it is certain, that the extracting the cube root of $81 + \sqrt{-2700}$ is of the same degree of difficulty, as the extracting the root of the original equation $r^3 - 63\,r = 162$; and that both require the tri-section of an angle for a perfect solution.

IRREGULAR, in grammar, such inflections of words as vary from the original rules: thus we say, irregular nouns, irregular verbs, &c.

IRRIGATION is the art of conducting water at pleasure over levels or inclined planes, in such manner that the whole may receive the benefit of partial immersion; whereby the surface may be duly supplied with moisture, and the vegetable productions intended to be encouraged, should be enabled to put forth abundantly, and to yield a good crop. Irrigation is with us rather a novel practice, but was well understood by the ancients, and has been in use among the Chinese up to the earliest dates of their records. In Hindostan, the whole of the rubbee, or small-grain crop, is artificially watered; the grain being deposited in October, while the ground remains moist, after the heavy rains which had fallen for months previously to the operations of tillage; so that the seed speedily germinates. But the perfect drought attendant on the five successive months, would infallibly destroy the promising verdure, were it not that the peasants divide their lands into small

squares, about four or five feet each way, between each pair of which a small channel, made by banking the soil, *pro tempore*, in a very simple manner, conducts the little stream supplied from numerous wells made expressly for the occasion. When the ear, or blossom, has shot forth, watering is discontinued. The Chinese proceed on the grand scale; they not only divide their fields by numerous channels, but even warp whole tracts of low land; whereby they insure immense returns. The Africans, in some parts, follow the Hindostanee plan; but raise their water chiefly from the rivers, or obtain their supplies of that invaluable element from natural reservoirs, formed by the hollows among hills. In every part of Asia, but especially in the Mysore country, formerly under the dominion of the late Sultan Tippoo, the retention of water, for the purposes of irrigation, is a matter of such importance as to be entirely under the auspices and controul of the government. Tippoo caused banks, or, as they are called in India, bunds, to be made between the bases of hills, so as to intercept the copious streams, which, during the rainy seasons, flow from the hilly country. An example worthy of imitation! Thus immense bodies of water might be collected in many parts of the United Kingdoms, whence mills and various machinery might be worked, without causing any waste of valuable land; the soil, in situations appropriate to such purposes, being for the most part poor, and unfit for tillage.

The Milanese territory exhibits the greatest expanse of irrigation known in Europe. In that country are to be seen noble canals running in every direction, totally exempted from local prejudice, private pique, or self-interest. All are under the authority and protection of government, which lets out the water to the various occupiers of meadows, at a fixed rate, according to the quantity supplied. Sometimes these canals are farmed out, by putting up the several sluices to auction; in other instances the canals go with the lands.

Whatever may be the manner in which their water is dispersed, its due preservation is an object of general solicitude, on account of the benefits which individuals derive from its use; while the government, both from that motive, and the support of the revenue produced by farming of the canals, do not allow the smallest despoliation to pass unpunished. We are assured, by the best authorities, that the whole of the pasture lands in the Milanese exhibit uncommon fertility; and that the canals are so very extensive, and the branches from them so numerous, that few need complain of a want of water for irrigation. These works are known to be of no modern date: some have existed for centuries, chiefly appertaining to monasteries; their waters being let out by measure to fertilize their adjacent lands. The great canal, known by the designation of Vecchiabbia, was in a flourishing state early in the eleventh century, beyond which we do not know what might have been its age. In 1220, the great canal of Adda, which waters the plains of Lodi, was finished; in 1305, the canal of Treveglio, which communicated with four others of very ancient workmanship, was completed; and in 1460, the canal of Martesano, extending thirty-two English miles: in this aqueduct, besides the main branch, of thirty-five feet in width, there were made nineteen scaricatori, or lesser canals, which served, when the waters rose very high, to draw off the surplus, so as to prevent injury to the main line, and to prevent inundation along its course: when the latter returned to a more tranquil state, the scaricatori, which were not so deep as the main line, served to supply it with what remained of their contents.

It is worthy our notice, that although the Italian aqueducts have, to our certain knowledge, been duly supported for upwards of eight centuries, by a race of people far beneath us in the more noble sciences, in wealth, in population, and in many other circumstances in which we pride ourselves; yet that Britain cannot boast of one aqueduct, made exclusively with the important view to improve her agriculture; though it would be as easy to shew a thousand situations where such canals would double the value of the lands adjoining, as it would be to prove that such value would be doubled.

It is, indeed, only in a few counties, that irrigation is carried on to any extent; though we may in various places see partial adoptions of this most beneficial practice: yet we daily observe situations naturally offering this advantage, without the smallest attempt being made to retain streams which, from elevated situations, glide with some velocity through deep vallies, whose very borders, perhaps, are verdant, but whose more retired parts would be doubled or trebled in value, by the influence of that element,

which is allowed to pass by unheeded, to be lost in some marsh, or eventually in the ocean! It is true, that, in some parts, irrigation is not understood; and, that it is not always practicable to obtain proper assistance; whence many, who would willingly water their meadows, are prevented from taking advantage of streams capable of effecting the intention. For the benefit of such persons, in particular, as well as of our readers in general, we shall endeavour to simplify, even this simple process, in such a manner as may prove perfectly intelligible; and, by showing with what ease irrigation may be carried on, induce a portion of our landholders to attempt, even without professional aid, or the tuition of experienced persons, that retention and gradual distribution of waters, whose sources are sufficiently elevated, which may favour such a slight and temporary inundation, as may give vigour and freshness both to the soil and to its produce.

We shall divide this subject into two distinct heads, *viz.* simple and compound irrigation; observing that the former may be practical in various modes separately, as will be shown, and that they may be blended so as to come under the second term. We shall also, by way of preparation, give the reader an insight into some modes of cutting off, or of supplying water, from sources of different heights, and under different circumstances: by this means, with a moderate portion of judgment, the novice in this art may speedily acquire sufficient of the principles to answer his own purposes, at least, if not to form a correct opinion of most of the cases which may come under his observation.

The greatest difficulty we generally experience is, from the water lying below the level of the lands over which it is to be conducted. In many instances, the springs whence streams are fed, lie very deep; and, though copious, for want of a sufficient inclination of their beds, move very slowly. In other parts, jealousy of improvement, personal enmity, the owner being a minor, or insane, and the property in the hands of trustees, or the estate being in Chancery, mortgaged, &c. perhaps debars the possibility of taking advantage of some peculiarly favourable fall, from which the water might be conducted with perfect facility and effect, over inclined planes, which, by their sterility, seem to reproach the owner with neglect!

In treating this subject, we must suppose the speculator to be a free agent, not shackled by such an unhappy neighbourhood; and content ourselves with cautioning him not to injure the property of others, such as mills, bleaching grounds below the lands, &c. &c., by drawing off that water on which their very existence depends: a want of attention to this particular, has ruined many a deserving and enterprising individual, and converted a blessing into a serious mischief!

Where the stream is rapid, the bed has usually a very marked declivity, such as admits of throwing the water over the lands, and of withdrawing them when they have flowed, in every part, to a sufficient height. The first step towards this, is to hold it up by means of a dam or weir, laid across the stream, (if its breadth admit, and that it be not navigable), so that, in the first place, the level may be raised as circumstances may admit. In this, it will be necessary to guard against injury to the property of other persons above the dam; for the raising a head of water, by means of a dam, might subject lands, which before were perfectly dry, to be inundated; and, even though such should actually prove beneficial thereto, the owners might recover in a court of law, under various pleas of damage.

The water should, if practicable, be raised to one foot, at least, above the level of the highest land to be irrigated; because that depth may be then kept as a surplus, in case of long-continued drought; being let in upon the first drain by a very small penstock, made only to the depth of the first level. The water, when abundant, may flow both into the upper level, and over the weir, so as to make a fall. When the water is not wanted over the land, the penstock may be shut up altogether. It is to be remarked, that authors of eminence in this branch differ in opinion, though some suppose water to be more richly impregnated with vegetable sustenance, in proportion as it is taken nearer to the spring; provided the water be clear. The lands over which it is made to flow, will be benefited in exact proportion as they may be near to the first level, which will always receive the most obvious benefit. In foul streams, the result is usually found to be in an inverse ratio; the water being richer, in proportion as it is more remote from its source, but the first level will still receive the greatest portion of the benefit. Where rivers are very mud-

dy, and of any magnitude, it is common to allow their flowing, to the depth of many feet, over low lands; so that, when kept stationary for a few hours, the fecula and sediment may be deposited; as is often the case, to the depth of many inches during a single tide; and give a new stratum of the finest soil. See Warping.

These points must be well understood, because they form a very prominent feature in the practice of irrigation, and will be found highly worthy the notice of all who lay their lands down with that intention. But we must observe, that many soils laying contiguous to streams, and well situated for irrigation, are naturally so rich, as not to depend on any deposit from the waters for their annual produce: such require but moderate watering, and, in some instances, more to be sheltered during the winter by complete inundation, than by refreshing flows. Where such prevail, the water ought to be admitted only when clear, and then from the very surface; in contra-distinction to poor, or dry soils, which want heart as well as moisture. The fact is, that, by means of an artificial supply of water, the grass will shoot out far more early, which is an object of the utmost importance to most farmers and graziers; and the crop will be much heavier than on lands not so watered. But the hay from watered meadows is frequently coarse, and not much relished by the more delicate classes of cattle. However, store cattle, which indeed scarcely ever refuse whatever is offered, will consume it with avidity. Another objection to hay from watered meadows is, that, being sometimes gritty, in consequence of the sediment deposited by muddy water, it is in a measure injurious to the teeth of those animals by which it is eaten. But the great importance of an early bite, for at least a month, in general, before other pastures are sufficiently forward to receive cattle, is of itself such a consideration as outweighs every objection, and causes watered meadows to yield double the rent given before they were subjected to irrigation. In many places the grass of watered meadows, from the fifteenth of March to the fifteenth of May, lets from twenty to twenty-five shillings per acre. The crop is usually two tons, in all seasons: in dry ones it is not subject to the ordinary risk of being burnt up; and, not only proves highly serviceable to the farmer himself, but to his neighbours; who thus obtain a supply of hay, when their own meadows have failed.

When land has been long watered, its qualities are meliorated considerably; but this is not the work of a day; and when the adjoining lands abound with coarse herbage, with water grasses especially, the crops will too frequently suffer by such vicinity. It will, at first view, appear strange, but it is nevertheless true, that swampy lands become firmer when regularly watered. In their natural state the water oozes upwards, and loosens the soil; but after the proper levels are found, and the catch drains are laid, so as to draw off the surplus water, the moisture is drawn downwards, and the finer parts get into the interstices, so as to compact the whole, and give a firm footing, where before even a sheep would have been bogged. We must, however, state, that though some watered meadows will bear cattle, it is by no means adviseable to let any thing heavier than a sheep feed upon them: the latter do little injury to the ridges, and by their close bite, as well as by their excellent manure, cause the grass to tiller forth, so as to form a close mat upon the soil. Whereas when large animals are allowed to tramp on the ridges, the borders of the drains are in general injured; and whenever, as will happen, the prints of their feet are left, the soil will become quaggy, and retain little pools, which infallably sour the grass, and negative the intention of watering. Hence clay soils are extremely difficult to improve by this operation; nor can such be reclaimed but by a very expensive course of draining, manuring, and breaking into a crumbly state: certainly clay soils may be formed into ridges, and grass may be made to grow upon them; but they will not produce sweet herbage; their surfaces will crack, their crops will be precarious, and their seasons for feeding must depend entirely on the dryness of the weather. Hence we may, in general terms, consider clay soils to be unfit for irrigation; the expense being great, and the money being more likely to yield a greater profit by other means; while their crops and pasturage are, in various points, of an inferior value.

But to proceed: the secondary drain, which supplies the whole of a field through which it passes, should be interrupted at every fall of four inches at farthest, by small sluices, or penstocks, and have small branch-drains cut to the right and left, in such manner as may cause the water to branch out into the whole expanse of its level. The turf cut from the surface of each drain, ought to

be placed, face downwards, between it and the land it is to overflow; being made firm and level, by beating with the flat of a spade. As the penstocks are situated just below the lines of the branch-drains above described, they keep up the water, so as to fill, and to cause their overflowing into the next inferior talus or slope, as shown in fig. 1 and 2, where A is the main drain, taken from the water-head or river, B; the drain C, C, C, C, shows the secondary drain, which, being on a declivity, would carry off all the water, were it not kept up at the places where the catch-drains, or branches, D, D, D, D, proceed laterally from it, by the sluices E, E, E, E. By this means, any particular level, either 1, 2, 3, 4, may be irrigated at pleasure, without wetting the others; the water being kept on by the sluice above, and carried away by the sluice appertaining to each level respectively. Or, if other meads at some distance are to be watered, the secondary channel, having all its sluices open, will convey it to them without interruption, when all its sluices are opened.

It is evident, that in this manner the whole of the water is carried down to the lowest level: hence it becomes a matter of no small importance to ascertain, that the whole shall either be absorbed or be carried off; so as not to injure the last level, which might otherwise be subjected to very considerable injury, were the inundation to be too long supported. The judicious computer will be cautious not to allow so much to remain as may rot his grass; in lieu of causing it to vegetate vigorously. This, in some situations, presents a very serious difficulty; for if the water is debarred free access to the lowest levels, they will be less fruitful than the others, which, exclusive of the great fecundity derived from first receiving the fluid, receive absolutely a larger portion of moisture. The greatest care is therefore requisite, to insure that the tail, or spent-water, shall be carried off. Where the declivity is considerable, and that the stream, or any other water-course, offers itself to receive such tail-water, at a due level beneath, there is no difficulty; but where the stream takes another course, and the descent is trifling, some artificial means must be resorted to. Perhaps no more simple or efficacious plan can be hit upon, than that of forming a fish-pond, of a suitable extent and depth, to receive the tail-water; whereby the apprehended damage may be avoided, and a useful store be created.

We shall show what we may term a truly ingenious device, whereby water may be laid upon lands that are above the level of the stream: it consists merely of an air-vessel, A, fig. 3, into which the water descends forcibly from the stream, B, and by compressing the air in the upper part, C, is itself forced to ascend through the conducting pipe, D, with such force as to rise to a level, E, far above that at which it formerly stood. This is the principle of the common fire-engine, which we are all sensible, can, when exerted, throw water to a great height. By such means, the tail-water may also be forced up to such a level as may cause it to return into the stream.

Where the stream runs through the lands that are watered, and that its declivity is moderate, it will sometimes be found difficult to restore the tail-water to its level. To effect this with as little expence as possible, wooden pipes should be laid from the lowest level of the land along the bank of the stream, but carried horizontally on a bank, to such extent as may suffice to convey the tail-water to the surface of the surface. This, however, is not applicable to all situations; for where the stream is very slow, its declivity would be very trifling. Where that happens, the air vessel will be found a good plan, provided the height to which the water is to be returned, be not considerable. In many situations, a water-wheel might answer well; observing, that in deep slow waters, that are broad, and under the speculator's own management, it will be best to throw a weir across, and then to let the whole body of the stream rush through a narrow slip, so as to turn a wheel placed immediately in the line of the water's run. By this device, the current may be made to pass that particular spot with sufficient velocity to turn a wheel; whereby water might either be raised out of the river, to supply a main drain, or the tail-water might be restored to the stream: in either case, one or more pumps would be necessary. (See fig. 4.)

The second mode of laying water over the land is by means of ridges, whose centres are occupied by small horizontal drains, out of which the water, furnished by the main drain, is allowed to flow to the depth of about an inch down each side of the pitch. These ridges should be from four to six feet measurement for each face; the drain being about a foot broad, and four inches deep; thus the whole breadth of a pitch, declining

each way equally, might occupy a base of about ten feet at the utmost. The declivities ought not to exceed an inch to the foot; in loose soils, not more than half an inch; else the finer parts will be washed away, and the drains, formed by the junctions of the ridges, will be filled up, whereby the water will be detained, and prevented from passing into the next level. Fig. 5, shows the profile, or section of a range of ridges on the same level, and fig. 6, displays an inclined plane, whereon ridges are formed in regular succession, the catch-drains being a little higher than the branch drains of the next lower level, so that the latter may be filled from the former: the water thus gradually descending, until the whole is gradually absorbed by the successive ridges; or the surplus is carried off by a large catch-drain, made to direct it into some other succession of ridges, as seen in the ground-plan, fig. 7.

The reader will perceive, that the levels may lay in any direction, according to the cast of the land; and, that where water can be had at a due height, all the land below it may be watered. It matters not if a deep valley lay between two declivities, to be watered by the same spring. A pipe, of suitable diameter, being made to descend one face, and to rise up the other, will convey the stream with facility to any part; so as to re-assume the level on the opposite side. For further insight into that circumstance, see FLUIDS, HYDRAULICS, and HYDROSTATICS.

It often happens, that small rivers have a very winding course among little hills, banks, rocky masses, &c., and that they suddenly lose many feet of their altitude, owing to a fall, or steep declivity; while the lower parts of the stream, being more expanded, and the water being kept up by another impediment, perhaps a few hundred yards lower, offer a seemingly invincible impediment to the conducting it over the finely-formed planes, which present themselves on either bank. Here the difficulty is far less than at first sight is supposed; since, by making an outlet from the superior level of the stream, through the bank which separates it from the planes to be watered, an abundant and certain supply may be obtained. Thus in fig. 8, the upper level, A, and fall, B, are shown, and the place pointed out where a cut, C, should be made, whereby the whole of the inclined plane, D, might be irrigated to the greatest advantage; the surplus-water, draining off into the lower level of still water, E, from which it would not be possible to raise the water to the superior parts of the inclined plane, C, D, without the aid of expensive machinery. This section will, we trust, prove completely satisfactory, by showing how necessary it is to look back to superior levels, often within reach.

Under the head of compound irrigation, we consider the various changes of direction, attended with an intermixture of the several modes laid down for simple irrigation. In the former, we occasionally find the water caught several times by the same stream, which, being obstructed at its several turns by weirs, sluices, &c., enables us to abbreviate the succession of ridges. This is a matter of great importance, because it renders a less body of water, in the branch-drains of the first level, equal to every purpose, and obviates the mischief that sometimes attends upon a numerous succession of levels, when the quantity of water required for the whole is forced through the first, in which, by its weight and volume, the roots of the grass are denudated, and the finer parts of the soil completely washed away. It is far better to give the stream a second, or even a third, turn through the land, than to allow all the water, necessary to moisten six or seven successive levels, to pass through the first. A reference to fig. 9, will give some idea of this mode; by the courses of the dotted lines, and arrows, the various descents may be understood.

With respect to the season for watering land, so many varieties prevail, in consequence of soil, and of locality, that we can only observe, in general terms, that where lands are to be inundated completely, by letting the water assume an unlimited range, and to expand over all parts which come under its level, such places require, during the winter season, to be kept well covered, that the frost may not attack the plants while saturated with moisture: if that were to happen, the whole would be destroyed; whereas, by a periodical inundation, the grass is sheltered from frost; and, by drawing off the water as the spring advances, and at intervals of about ten days, when the weather is fair, such grass will shoot out vigorously, and afford a very early bite for cattle, at that season when green food is both valuable and scarce. The same principle may be followed, though the practice is different, in places watered by drains. In such, the greatest care ought to be taken to avoid throwing on the water while the air is frosty; but so soon as

the weather opens, the ground ought to be moderately moistened. The sun's power should guide us to the frequency and quantity of water; nor should its quality be overlooked: water from warm soils will produce effects widely different from the streams flowing out of clay lands, or such as are impregnated with iron, &c. the best water usually rises out of gravelly or chalky lands. It is better to throw the water on early in the day, during cold weather, in order that the grass may dry well, and the danger apprehended from frosty nights be obviated; but in summer, the watering should take place late in the evening, whereby the ground will be cold, without danger of scorching the plants.

We have dwelt thus long on the subject of irrigation, under the conviction of its extreme importance: the reader may, under the head of AGRICULTURE, find a few additional remarks, which were given with the view to bringing all matters relating to farming under one general head, while we reserved this mechanical part to be separately treated, under its proper designation.

IRRITABILITY, in physiology, is the property peculiar to the muscles, by which they contract upon the application of certain stimuli, without a consciousness of action. Haller and other physiologists denominate that part of the human body irritable, which becomes shorter by being touched: *very* irritable, if it contracts upon a slight touch. They call that a sensible part of the human body, which, upon being touched, transmits the impression of it to the mind: on the contrary, they call that insensible, which, being burnt, torn, cut, &c. occasions no sign of pain or convulsion, nor any sort of change in the situation of the body. It is inferred that the epidermis is insensible; that the true skin is the most sensible part of the body; that the fat and cellular membranes are insensible; and the muscular flesh sensible, the sensibility of which he ascribes rather to the nerves than the flesh itself. The tendons, having no nerves distributed among them, are deemed insensible. Irritability then is the distinguishing characteristic between the muscular and cellular fibres. Irritability differs from sensibility, and is not proportioned to it: the intestines are less sensible than the stomach, but more irritable; the heart is very irritable, though it has but a small degree of sensation. The laws of irritability, according to Dr. Crichton, are: 1. After every action in an irritable part, a state of rest, or cessation from motion, must take place, before the irritable part can be again incited to action. If by an act of volition we throw any of our muscles into action, that action can only be continued for a certain space of time; the muscle becomes relaxed, notwithstanding all our endeavours to the contrary, and remains a certain time in that relaxed state, before it can be again thrown into action. 2. Each irritable part has a certain portion or quantity of the principle of irritability which is natural to it, part of which it loses during action, or from the application of stimuli. 3. By a process, wholly unknown to us, it regains this lost quantity during its repose or state of rest. In order to express the different quantities of irritability in any part, we say that it is either more or less redundant, or more or less defective. It becomes redundant in a part, when the stimuli which are calculated to act on that part are withdrawn, or withheld for a certain length of time, because then no action can take place; while, on the other hand, the application of stimuli causes it to be exhausted, or to be deficient, not only by exciting action, but by some secret influence, the nature of which has not yet been detected; for it is a circumstance extremely deserving of attention, that an irritable part or body may be suddenly deprived of its irritability by powerful stimuli, and yet no apparent cause of muscular or vascular action takes place at the time. Thus a certain quantity of spirits taken at once into the stomach kills almost as instantaneously as lightning does: the same thing may be observed of some poisons, as opium, laurel-water, the juice of some poisonous vegetables, &c. 4. Each irritable part has stimuli which are peculiar to it; and which are intended to support its natural action: thus blood, which is the stimulus proper to the heart and arteries, if by any accident it gets into the stomach, produces sickness or vomiting. 5. Each irritable part differs from the rest in regard to the quantity of irritability which it possesses. This law explains to us the reason of the great diversity which we observe in the action of various irritable parts: thus the muscles of voluntary motion can remain a long time in a state of action, and if it be continued as long as possible, another considerable portion of time is required before they regain the irritability they lost; but the heart and arteries have a more short and sudden action, and their state of rest is equally so. The circular muscles of the intestines have also a quick ac-

tion and short rest. 6. All stimuli produce action in proportion to their irritating powers. As a person approaches his hand to the fire, the action of all the vessels in the skin is increased, and it glows with heat; if the hand be approached still nearer, the action is increased to such an unusual degree as to occasion redness and pain; and if it be continued too long, real inflammation takes place; but if this heat be continued, the part at least loses its irritability, and a sphacelus or gangrene ensues. 7. The action of every stimulus is in an inverse ratio to the frequency of its application. A small quantity of spirits taken into the stomach, increases the action of its muscular coat, and also of its various vessels, so that digestion is thereby facilitated. If the same quantity, however, be taken frequently, it loses its effect. In order to produce the same effect as at first, a larger quantity is necessary; and hence the origin of dram-drinking. 8. The more the irritability of a part is accumulated, the more that part is disposed to be acted upon. It is on this account that the activity of all animals, while in perfect health, is much livelier in the morning than at any other time of the day; for during the night the irritability of the whole frame, and especially that of the muscles destined for labour, *viz.* the muscles of voluntary action, is re-accumulated. The same law explains why digestion goes on more rapidly the first hour after food is swallowed than at any other time; and it also accounts for the great danger that accrues to a famished person upon first taking in food. 9. If the stimuli which keep up the action of any irritable body be withdrawn for too great a length of time, that process on which the formation of the principle depends is gradually diminished, and at last entirely destroyed. When the irritability of the system is too quickly exhausted by heat, as is the case in certain warm climates, the application of cold invigorates the frame, because cold is a mere diminution of the overplus of that stimulus which was causing the rapid consumption of the principle. Under such, or similar circumstances, therefore, cold is a tonic remedy; but if in a climate naturally cold, a person were to go into a cold bath, and not soon return into a warmer atmosphere, it would destroy life just in the same manner as many poor people, who have no comfortable dwellings, are often destroyed from being too long exposed to the cold in winter. Upon the first application of cold the irritability is accumulated, and the vascular system therefore is disposed to great action; but after a certain time all action is so much diminished, that the process, whatever it be, on which the formation of the irritable principle depends, is entirely lost. See Dr. Crichton on Mental Derangement for more on this subject.

ISATIS, in botany, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ or Cruciformes. Cruciferæ, Jussieu. Essential character; silicle lanceolate, one-celled, one-seeded, deciduous, bivalve; valves nivicular. There are five species, of which I. tinctoria, dyer's woad, is a biennial plant, with a fusiform, fibrous root; stem upright, round and smooth, woody at bottom, branched at top; stem leaves from two to three inches long, and scarcely half an inch in breadth; flowers small, terminating the stem and branches in a close raceme; both corolla and calyx yellow; petals notched at the end; seed vessels on slender peduncles, hanging down, chesnut coloured or dark brown, shining when ripe, of an oblong elliptic form, compressed at top and on the sides into a sharp edge, swelling like a convex lens in the middle; cotyledons ovate, fleshy, plano convex; radicle subcylindrical, bent in upwards. It is a native of most parts of Europe. Woad is much used by dyers for its blue colour: it is the basis of black and many other colours.

ISCHÆMUM, in botany, a genus of the Polygamia Monoecia class and order. Natural order of Gramina, or Grasses. Gramineæ, Jussieu. Essential character: hermaphrodite calyx; glume two-flowered; corolla two-valved; stamens three; styles three; seed one: male, calyx and corolla as in the other; stamens three. There are eight species.

ISERINE, in mineralogy, a species of the Menachine genus: it is of an iron-black, inclining a little to the brownish-black; it occurs in small, obtuse, angular grains, and in rolled pieces, with a rough glimmering surface. Internally it is glistering, and its lustre is semi-metallic. Specific gravity 4.5. Before the blowpipe, it melts into a blackish-brown coloured glass, which is slightly attracted by the magnet. It is composed of

Oxide of menachine	59.1
——— iron	30.1
——— uran	10.2
	99.4
Loss	6
	100.0

It bears a great resemblance to iron sand in colour, but in specific gravity it differs, as also in its being very slightly attractable by a powerful magnet. It is found on high mountains in Germany.

ISERTIA, in botany, a genus of the Hexandria Monogynia class and order. Essential character: calyx coloured, four or six-toothed; corolla six-cleft, funnel form; pome sub-globular, six celled, many seeded. There is but one species, *viz.* I. coccinea, a tree with a trunk ten or twelve feet in height, and about eight inches in diameter; the bark is wrinkled, and of a russet colour; the wood light, and of a loose texture; branches quadrangular, straight, with opposite branchlets, channelled and covered with a russet down; each branchlet has three flowers, of which that in the middle is sessile; calyx purplish; tube of the corolla two inches long of a bright red; border yellow, covered on the inside with hairs of the same colour; fruit a succulent red berry or pome, the size of a cherry, sweet and good to eat. The wood is bitter; a decoction of leaves is used by the Creoles in fomentations. It is common in the island of Cayenne, and on the continent of Guiana, flowering and bearing fruit a great part of the year.

ISINGLASS, used in medicine and domestic economy, is a preparation formerly made only from a fish named huso, a species of the Accipenser genus. We have, in the sixty-third volume of the transactions of the Royal Society, a full account of the mode of preparing this substance, of which we shall give an extract.

The sounds, or air-bladders, of fresh water fish in general, are preferred for this purpose, as being the most transparent, flexible, delicate substances. These constitute the finest sorts of isinglass; those called book and ordinary staple are made of the intestines, and probably of the peritonæum of the fish. The belluga yields the greatest quantity, as being the largest and most plentiful fish in the Muscovy rivers; but the sounds of all fresh water fish yield, more or less, fine isinglass, particularly the smaller sorts, found in prodigious quantities in the Caspian sea, and several hundred miles beyond Astracan, in the Wolga, Yaik, Don, and even ar far as Siberia, where it is called kle or kla by the natives, which implies a glutinous matter; it is the basis of the Russian glue, which is preferred to all other kinds for its strength The sounds, which yield the finer isinglass, consist of parallel fibres, and are easily rent longitudinally; but the ordinary sorts are found composed of double membranes, whose fibres cross each other obliquely, resembling the coats of a bladder; hence the former are more readily pervaded and divided with subacid liquors; but the latter, through a peculiar kind of interwoven texture, are with great difficulty torn asunder, and long resist the power of the same menstruum; yet, when duly resolved, are found to act with equal energy in clarifying liquors.

Isinglass receives its different shapes in the following manner. The parts of which it is composed, particularly the sounds, are taken from the fish while sweet and fresh, slit open, washed from their slimy sordes, divested of every thin membrane which envelops the sound, and then exposed to stiffen a little in the air. In this state, they are formed into rolls about the thickness of a finger, and in length according to the intended size of the staple: a thin membrane is generally selected for the centre of the roll, round which the rest are folded alternately, and about half an inch of each extremity of the roll is turned inwards. The due dimensions being thus obtained, the two ends of what is called short staple are pinned together with a small wooden peg; the middle of the roll is then pressed a little downwards, which gives it the resemblance of a heart-shape, and thus it is laid on boards, or hung up in the air to dry.

The sounds, which compose the long-staple, are longer than the former; but the operator lengthens this sort at pleasure, by interfolding the ends of one or more pieces of the sound with each other. The extremities are fastened with a peg, like the former; but the middle part of the roll is bent more considerably downwards, and, in order to preserve the shape of the three obtuse angles thus formed, a piece of round stick, about a quarter of an inch diameter, is fastened in each angle with small wooden pegs, in the same manner as the ends. In this state, it is permitted to dry long enough to retain its form, when the pegs and sticks are taken out, and the drying completed; lastly, the pieces of isinglass are colligated in rows, by running pack-thread through the peg-holes, for convenience of package and exportation. That called cake-isinglass, is formed of the bits and fragments of the staple-sorts, put into a flat metalline pan, with a very little water, and heated just enough to make the parts cohere like a pancake when it is dried; but frequently it is overheated, and such pieces, as before observed, are useless in the business

of fining. Experience has taught the consumers to reject them.

Isinglass is best made in the summer, as frost gives it a disagreeable colour, deprives it of weight, and impairs its gelatinous principles; its fashionable forms are unnecessary, and frequently injurious to its native qualities. It is common to find oily putrid matter, and exuviæ of insects, between the implicated membranes, which, through the inattention of the cellarman, often contaminate wines and malt liquors in the act of clarification.

These peculiar shapes might probably be introduced originally with a view to conceal and disguise the real substance of isinglass, and preserve the monopoly; but, as the mask is now taken off, it cannot be doubted to answer every purpose more effectually in its native state, without any subsequent manufacture whatever, especially to the principal consumers, who hence will be enabled to procure sufficient supply from the British colonies. Until this laudable end can be fully accomplished, and as a species of isinglass, more easily produceable from the marine fisheries, may probably be more immediately encouraged, it may be manufactured as follows. The sounds of cod and ling bear great analogy with those of the accipenser genus of Linnæus and Artedi; and are in general so well known as to require no particular description. The Newfoundland and Iceland fishermen split open the fish as soon as taken, and throw the back bones, with the sounds annexed, in a heap; but previously to incipient putrefaction, the sounds are cut out, washed from their slimes, and salted for use. In cutting out the sounds, the intercostal parts are left behind, which are much the best; the Iceland fishermen are so sensible of this, that they beat the bone upon a block with a thick stick, till the pockets, as they term them, come out easily, and thus preserve the sound entire. If the sounds have been cured with salt, that must be dissolved by steeping them in water before they are prepared for isinglass; the fresh sound must then be laid upon a block of wood, whose surface is a little elliptical, to the end of which a small hair-brush is nailed, and with a saw knife the membranes on each side of the sound must be scraped off. The knife is rubbed upon the brush occasionally, to clear its teeth; the pockets are cut open with scissars, and perfectly cleansed of the mucous matter with a coarse cloth; the sounds are afterwards washed a few minutes in lime-water, in order to absorb their oily principle, and lastly in clear water. They are then laid upon nets to dry, but if intended to resemble the foreign isinglass, the sound of the cod will only admit of that called book, but those of ling both shapes. The thicker the sounds are the better the isinglass.

ISIS, *coral*, in natural history, a genus of the Vermes Zoophyta class and order. Animal growing in the form of a plant; stem stony, jointed, the joints longitudinally striate, united by spongy or horny junctures, and covered by a soft porous cellular flesh or bark; mouth beset with oviparous polypes. There are six species. I. hippuris; with white striate joints and black junctures; it is found chiefly in the Indian seas, growing to rocks, and is from two inches to two feet long. I. entrocha; stem testaceous, round, with orbicular perforated joints and verticillate dichotomous branches. Inhabits the ocean. The stem is about the thickness of a finger, with crowded flat orbicular joints perforated in the centre, the perforation is pentangular, with the disk substriate from the centre; outer bark or flesh unequal, and surrounded with a row of tubercles; branches thin, dichotomous, continued, not jointed.

ISLAND, or Iceland, *crystal*, a body famous among the writers of optics, for its property of a double refraction; but improperly called by that name, as it has none of the distinguishing characters of crystal, and is plainly a body of another class. Dr. Hill has reduced it to its proper class, and determined it to be of a genus of spars, which he has called, from their figure, parallelopipedia, and of which he has described several species, all of which, as well as some other bodies of a different genus, have the same properties. Bartholine, Huygens, and Sir Isaac Newton, have described the body at large, but have accounted it either a crystal or a talc; errors which could not have happened, had the criterions of fossils been at that time fixed; since Sir Isaac Newton has recorded its property of making an ebullition with aquafortis, which alone must prove, that it is neither talc nor crystal, both those bodies being wholly unaffected by that menstruum. See Crystal, Oryctology, and Talc.

It is always found in form of an oblique parallelopiped, with six sides, and is found of various sizes, from a quarter of an inch to three inches or more in diameter. It is pellucid, and not much less bright than the purest crystal, and its planes are all tolerably smooth, though, when nicely viewed, they are found to be waved with

crooked lines, made by the edges of imperfect plates.

What appears very singular in the structure of this body is, that all the surfaces are placed in the same manner, and consequently it will split off into thin plates, either horizontally or perpendicularly; but this is found, on a miscroscopic examination, to be owing to the regularity of figure, smoothness of surface, and nice joining of the several small parallelopiped concretions, of which the whole is composed; and to the same cause is probably owing its remarkable property in refraction. See OPTICS, and REFRACTION.

It is very soft, and easily scratched with the point of a pin; it will not give fire on being struck against steel, and ferments, and is perfectly dissolved in aquafortis. It is found in Iceland, from whence it has its name; and in France, Germany, and many other places. In England, fragments of other spars are very often mistaken for it, many of them having in some degree the same property.

ISNARDIA, in botany, so named in memory of Mons. Antoine Danti d'Isnard, member of the Academy of Sciences, a genus of the Tetrandria Monogynia class and order. Natural order of Calycanthemæ. Salicariæ, Jussieu. Essential character: calyx four-cleft; corolla none; capsule four-celled, covered by the calyx. There is but one species, viz. I. palustris, which bears a great resemblance to peplis portulaca; it is creeping and floating; the flowers are axillary, opposite, sessile, and green. It is a native of Italy, France, Alsace, Russia, Jamaica, and Virginia, in rivers.

ISOCHRONAL, ISOCHRONE, or ISOCHRONOUS, is applied to such vibrations of a pendulum as are performed in the same space of time as all the vibrations or swings of the same pendulum are, whether the arches it describes be longer or shorter: for when it describes a shorter arch, it moves so much the slower, and when a long one, proportionably faster.

ISOCHRONAL *line*, that in which a heavy body is supposed to descend without any acceleration.

M. Leibnitz shows, that an heavy body, with a degree of velocity acquired by the descent from any height, may descend from the same point by an infinite number of isochronal curves, all which are of the same species, differing from one another only in the magnitude of their perimeters; such are all the quadratocubical paroboloids, and consequently similar to one another. He shows also there, how to find a line in which a heavy body descending shall recede uniformly from a given point, or approach uniformly to it.

ISOETES, in botany, a genus of the Cryptogamia Filices class and order. Natural order of Filices, or Ferns. Essential character: male, anther within the base of the frond: female, capsule two-celled, within the base of the frond. There are two species, *viz.* I. lacustris, common quillwort, and I. coromandelina, Coromandel quillwort, both natives of mountain lakes, and in wet places that are inundated in the rainy season.

ISOPERIMETRICAL *figures*, in geometry, are such as have equal perimeters, or circumferences.

Isoperimetrical lines and figures have greatly engaged the attention of mathematicians at all times. The fifth book of Pappus's Collections is chiefly upon this subject; where a great variety of curious and important properties are demonstrated, both of planes and solids, some of which were then old in his time, and many new ones of his own. Indeed, it seems, he has here brought together into this book all the properties relating to isoperimetrical figures then known, and their different degrees of capacity. The analysis of the general problem concerning figures, that, among all those of the same perimeter, produce maxima and minima, was given by Mr. James Bernoulli, from computations that involve the second and third fluxions. And several enquiries of this nature have been since prosecuted in like manner, but not always with equal success. Mr. Maclaurin, to vindicate the doctrines of fluxions from the imputation of uncertainty or obscurity, has illustrated this subject, which is considered as one of the most abstruse parts of this doctrine, by giving the resolution and composition of these problems by first fluxions only; and in a manner that suggests a synthetic demonstration, serving to verify the solution. See Maclaurin's Fluxions. Mr. Crane also, in the Berlin Memoirs for 1752, has given a paper, in which he proposes to demonstrate, in general, what can be demonstrated only of regular figures in the elements of geometry, *viz.* that the circle is the greatest of all isoperimetrical figures, regular or irregular. We shall now mention a few of the properties of isoperimetrical figures.

1. Of isoperimetrical figures, that is the greatest that contains the greatest number of sides, or the most angles, and consequently a circle, is the greatest of all figures that have the same ambit as it has.

2. Of two isoperimetrical triangles, having the same base, whereof two sides of one are equal, and of the other unequal, that is the greater whose two sides are equal.

3. Of isoperimetrical figures, whose sides are equal in number, that is the greatest which is equilateral and equiangular. From hence follows that common problem of making the hedging or walling that will wall in one acre, or even any determinate number of acres, a; fence or wall in any greater number of acres whatever, b. In order to the solution of this problem, let the greater number, b, be supposed a square; let x be one side of an oblong, whose area is a: then will $\frac{a}{x}$ be the other side; and $2\frac{a}{x}+2x$ will be the ambit of the oblong, which must be equal to four times the square root of b; that is, $2\frac{a}{x}+2x=4\sqrt{b}$. Whence the value of x may be easily had, and you may make infinite numbers of squares and oblongs that have the same ambit, and yet shall have different given areas.

Let $\sqrt{b}=d$

$$\text{Then } \frac{2a+4xx}{x}=4d$$
$$a+2xx=2dx$$
$$2xx-2dx=-a$$
$$xx-dx=-\frac{a}{2}$$
$$xx-dx+\tfrac{1}{4}dd=-\frac{a}{2}+\tfrac{1}{4}dd$$
$$x=\sqrt{-\frac{a}{2}+\tfrac{1}{4}dd}+\tfrac{1}{2}d$$

Thus if one side of the square be 10, and one side of an oblong be 19, and the other 1; then will the ambits of that square and oblong be equal, *viz.* each 40, and yet the area of the square will be 100, and of the oblong but 19.

ISOPYRUM, in botany, a genus of the Polyandria Polygynia class and order. Natural order of Multisilique. Ranunculaceæ, Jussieu. Essential character: calyx none; petals five; nectary trifid, tubular; capsule recurved, many-seeded. There are three species.

ISOSCELES *triangle*, in geometry, one that has two equal sides. See GEOMETRY.

ISSUE, in law, has many significations, sometimes being used for the children begotten between a man and his wife; sometimes for profit growing from amercements or fines; and sometimes for profits of lands or tenements; sometimes for that point of matter depending in a suit, when, in the course of pleading, the parties in the case affirm a thing on one side, and deny it on the other, they are then said to be at issue; all their debates being at last contracted into a single point, which may be determined either in favour of the plaintiff or defendant.

ISSUES, in surgery, are little ulcers made designedly by the surgeon in various parts of the body, and kept open by the patient for the preservation or recovery of his health.

ITCH, a cutaneous disease, supposed to be caused by an insect, a species of the genus Acarus, *viz.* A. scabiei, which, when viewed by a good microscope, is white with reddish legs; the four hind ones having a long bristle. It is found in the small pellucid vesicles with which the hands and joints of persons infected with the itch are covered. It appears to be not only the cause of the disorder, but the reason why it is so highly infectious.

ITCHING, an uneasy sensation, which occasions a desire of scratching the place affected. It is frequently a troublesome sensation, but more nearly allied to pleasure than pain. As pain is supposed to proceed from too great an irritation, so does itching proceed from a slight one. Certain species of itching excites people to many necessary actions, as the excretion of the feces and urine; coughing, sneezing, &c.

ITEA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Rhododendra, Jussieu. Essential character: capsule two-celled, two-valved, many-seeded; stigma emarginate. There are two species, *viz.* I. virginica. Virginian itea; and I. cyrilla, entire-leaved itea. These are both shrubs. Linnæus remarks, that the itea virginica has the appearance of the Padus; that the leaves are petioled and the flowers in terminating racemes. The stigma is headed in this species, whereas in the other it is bifid or double; the former is a native of North America; the latter of Carolina and Jamaica.

ITTRIA. This earth was discovered by Gadolin, a Swedish chemist, in a fossil, found at Ytterby, in Sweden, which has since received the name of gadolinite, and in which it is combined with silex and lime. The discovery was confirmed by Ekeberg, Klaproth, and Vauquelin; and the same earth has been discovered in some other fossils, particularly combined with lantalium. In several of its properties ittria resembles glucine, particularly in forming salts of a sweet taste, and in being soluble in carbonate of ammonia; but it differs entirely in others.

The process followed by Vauquelin to obtain this earth from the gadolinite was, to dissolve it, with the assistance of heat, in diluted nitric acid, pouring off the solution from the undissolved silex. The liquor is then evaporated to dryness, by which any remaining silex and any oxide of iron is separated from combination with the acid. By redissolving the residuum in water, the compound of nitric acid and ittria is obtained: if there are any traces of iron, the liquor is either again evaporated to dryness, or a little ammonia is added; and after the separation of the oxide of iron by yellow flakes, the solution is decomposed by ammonia, which precipitates the new earth. (Philosophical Magazine, vol. viii. p. 369.) The process employed by Klaproth is similar, nitro-muriatic acid being employed; the iron being removed by the action of succinate of soda; and the ittria being precipitated by carbonate of soda. (Analytical Essays, vol. ii. p. 47.)

Ittria is obtained in the form of a white powder, and is heaver than any other earth; its specific gravity according to Ekeberg being 4.842. It is not fusible alone, but with borax it forms a white glass. It is not soluble in water, but it retains that fluid with considerable force.

Ittria combines with the acids; its salts, as has been remarked, having generally a sweetish taste. Several of them, too, are coloured, a property in which it differs from all the other earths.

The sulphate of ittria crystallizes in small brilliant grains, according to Klaproth, of a rhomboidal form, and of a colour inclining to an amethyst red. Their taste is sweet, becoming also astringent. They require from twenty-five to thirty parts of water, and are not more soluble in hot water. Their specific gravity is 2.79. The sulphuric acid is expelled by a red heat. Nitrate of ittria can scarcely be crystallized; it assumes a gelatinous consistence by evaporation, and becomes brittle when this jelly cools. Its taste is similar to that of the sulphate. The muriate is obtained nearly in the same form. The phosphate, formed by complex affinity, is insoluble. The acetite is a crystallizable salt of a pale red colour.

The salts of ittria are decomposed by the three alkalies, and by lime, astrontites, and barytes.

Ittria is not dissolved by the liquid alkalies, nor do they redissolve it when added in excess, after having precipitated it from its solutions. This affords a distinguishing character between it and glucine. It is soluble in the alkaline carbonates, particularly in the carbonate of ammonia.

Prussiate of potash throws down from its solution a granular precipitate, of a white or pearl-grey colour. It is also precipitated in grey flocculi by the watery or spirituous infusion of galls; but very slightly by the pure gallic acid. It is not affected by sulphuretted hydrogen, or hydro-sulphuret of ammonia, added to its solutions.

The great specific gravity of this earth, its forming coloured salts, and being precipitated by the alkaline prussiates, and by tannin, from its solutions, in some measure connect it with the metals, and lead to the suspicion that it may be a metallic oxide.

The gadolinite is the only fossil that can be considered as belonging to the genus of which this earth is the base, for the yttrotantalite contains it in small quantity only, and is properly a metallic fossil belonging to the genus Tantalium. The gadolinite occurs massive, and disseminated; its colour is a deep greenish black. Its internal lustre is resplendent; it is opaque; its fracture is conchoidal; its hardness is such, that it is not scratched by the knife; its specific gravity is 4.2. It intumesces before the blow-pipe, but is not fused. With nitric acid it forms a gelatinous solution. According to Klaproth, it consists of ittria 59.75, silex 21.25, oxide of iron 17.5, argil 0.5, water 0.5. The analysis of it by Ekeberg and Vauquelin, give the proportion of ittria rather less, and of silex and iron somewhat more.

IVA, in botany, a genus of the Monoecia Pentandria class and order. Natural order of Compositæ Nucamentaceæ. Corymbiferæ, Jussieu. Essential character: male, calyx common, three-leaved; corolla of the disk, one-petalled, five-cleft; receptacle with hairs or linear chaffs: female, in the ray, five, or fewer; corolla none; styles two, long; seeds naked, blunt. There are two species, viz. I. annua, annual iva, and I. frutescens, shrubby iva, or bastard Jesuits' bark tree.

JUBILEE, a time of public and solemn festivity among the ancient Hebrews. This was kept every fiftieth year: it began about the autumnal equinox, and was proclaimed by sound of trumpet throughout all the country. At this time all slaves were released, all debts annihilated, and all lands, houses, wives, and children, however alienated, were restored to their first owners. During this whole year, all kind of agriculture was forbidden, and the poor had the benefit of the harvest,

vintage, and other productions of the earth, in the same manner as in the sabbatic, or seventh year. As this was designed to put the Israelites in mind of their Egyptian servitude, and to prevent their imposing the like upon their brethren, it was not observed by the Gentile proselytes.

The Christians, in imitation of the Jews, have likewise established jubilees, which began in the time of Pope Boniface VIII. in the year 1300, and are now practised every twenty-five years; but these relate only to the pretended forgiveness of sins, and the indulgences granted by the church of Rome.

JUDGE. The judges are the chief magistrates in the law, to try civil and criminal causes. Of these there are twelve in England, viz. the Lords Chief Justices of the Courts of King's Bench and Common Pleas; the Lord Chief Baron of the Exchequer; the three puisne or inferior judges of the two former courts, and the three puisne barons of the latter. By statute 1 Geo. III. c. 23, the judges are to continue in their offices during their good behaviour, notwithstanding any demise of the crown, (which was formerly held immediately to vacate their seats) and their full salaries are absolutely secured to them during the continuance of their commissions, by which means the judges are rendered completely independent of the king, his ministers, or his successors. A judge, at his creation, takes an oath that he will serve the king, and indifferently administer justice to all men, without respect of persons, take no bribe, give no counsel where he is a party, nor deny right to any, though the king or any other, by letters, or by expressed words, command the contrary, &c. and in default of duty, to be answerable to the king in body, land, and goods. Where a judge has an interest, neither he nor his deputy can determine a cause, or sit in court, and if he do, a prohibition lies.

Judges are punishable for wilful offences against the duty of their situations; instances of which happily live only in remembrance.

A judge is not answerable to the king, or the party, for mistakes or errors in his judgment, in a matter of which he has jurisdiction.

JUDGMENT, among logicians, a faculty, or rather act, of the human soul, whereby it compares its ideas, and perceives their agreement or disagreement.

JUDGMENT. The opinion of the judges is so called, and is the very voice and final doom of the law; and, therefore, is always taken for unquestionable truth; or it is the sentence of the law pronounced by the court upon the matter contained in the record. Judgments are of four sorts, *viz.* 1. Where the facts are confessed by the parties, and the law determined by the court, which is termed judgment by demurrer. 2. Where the law is admitted by the parties, and the facts only are disputed, as in judgment upon a demurrer. 3. Where both the fact and the law arising thereon, are admitted by the defendant, as in case of judgment by confession or default. 4. Where the plaintiff is convinced that fact or law, or both, are insufficient to support his action, and therefore abandons or withdraws his prosecution, as in case of judgment upon a nonsuit or retraxit. See WARRANT of ATTORNEY.

Judgments are either interlocutory or final. Interlocutory judgments are such as are given in the middle of a cause, upon some plea, proceeding, or default, which is only intermediate, and doth not finally determine or complete the suit; as upon dilatory pleas, when the judgment in many cases is, that the defendant shall answer over, that is, put in a more substantial plea. Final judgments are such as at once put an end to the action, by declaring that the plaintiff hath either entitled himself, or hath not, to recover the remedy he sues for.

JUGLANS, in botany, *walnut tree*, a genus of the Monoecia Polyandria class and order. Natural order of Amentaceæ. Terebintaceæ, Jussieu. Essential character: male, calyx one-leafed, scale-form; corolla six-parted; filaments eighteen; female, calyx four-cleft, superior; corolla four-parted; styles two; drupe with a grooved nucleus. There are eight species, of which J. regia, common walnut, is a very large and lofty tree, with strong spreading boughs. There are several varieties, but they all vary again when raised from the seed, and nuts from the same tree will produce different fruit: persons, therefore, who plant the walnut for its fruit, should make choice of the trees in the nurseries when they have their fruit upon them. In France, Switzerland, &c. the wood is in great request for furniture, as it was formerly in England, till the use of mahogany superseded it; it is in great repute with the joiner, for the best grained and coloured wainscot; with the gun-smith, for stocks; with the coach-maker, for wheels and the bodies of coaches; with the cabinet-maker, for inlayings, especially the firm and close timber about the root, which is admirable

for flecked and cambleted works. To render this wood the better coloured, joiners put the boards into an oven, after the batch is out, or lay them in a warm stable; and when they work it, polish it over with its own oil very hot, which makes it look black and sleek, and the older it is the more estimable. The husks and leaves being macerated in warm water, and the liquor poured on grass walks and bowling-greens, will infallibly kill the worms, without endangering the grass. Not that there is any thing peculiarly noxious in this decoction; but worms cannot bear the application of any thing bitter to their bodies, which is the reason that bitters, such as gentian, are the best destroyers of worms lodged in the bodies of animals.

JUGULAR, in anatomy, an appellation given to two veins of the neck, which arise from the subclavians. See ANATOMY.

JUGULARES, in natural history, an order of fishes, according to the Linnæan system. The fishes of this order have their ventral fins situated before the pectoral fins, and, as it were, under the throat. They are mostly inhabitants of the sea. Their body is sometimes covered with scales, and sometimes not. With a very few exceptions, they have spines in the dorsal and anal fins, and their gills have bony rays. Of this order there are the following genera:

Blennius	Kurtus
Callyonimus	Trachinus
Gadus	Uranoscopus

JULIAN *period*, in chronology, a system or period of 7980 years, found by multiplying the three cycles of the sun, moon, and indiction, into one another. See CHRONOLOGY.

This period was called the Julian, not because invented by Julius Cæsar; since the Julian epocha was not received till the year 4669, but because the system consists of Julian years. This epocha is not historical, but artificial, being invented only for the use of true epochas; for Scaliger, considering that the calculation was very intricate in using the years of the creation, the years before Christ, or any other epocha whatever, in regard that another person could not understand what year this or that writer meant; to remove such doubts in the computation of time, he thought of this period: which commencing 710 years before the beginning of the world, the various opinions concerning other epochas may commodiously be referred to it. See EPOCHA.

The most remarkable uses of the Julian period are as follow: 1. That we can explain our mind to one another, for every year in this period has its peculiar cycles, which no other year in the whole period has; whereas, on the contrary, if we reckon by the years of the world, we must first enquire how many years any other reckons from the creation to the year of Christ, which multiple-inquisition is troublesome and full of difficulties, according to the method of other periods. 2. That the three cycles of the sun, moon and indiction, are easily found in this period. 3. That if it be known how the chronological characters are to be found in this period, and how the years of any other epocha are to be connected with the years of it, the same characters also may, with little labour, be applied to the years of all other epochas.

JULUS, in natural history, a genus of insects of the order Aptera. Lip crenate, emarginate; antennæ moniliform; two feelers, filiform; body long, semicylindrical, consisting of numerous transverse segments; legs numerous, twice as many on each side as there are segments of the body. There are fourteen species, of which we shall notice the J. Indus, or great Indian julus, which is six or seven inches long; found in the warmer parts of Asia and America, inhabiting woods and other retired places. It has 115 legs on each side; the body is ferruginous; legs yellow; the last segment of the body is pointed. The most common species is the J. sabulosus, about an inch and a quarter long; the colour brownish black, except the legs, which are pale or whitish; it is an oviparous animal; and the young when first hatched are small and white, and furnished with only three pair of legs, situated near the head; the remaining pairs, in all 120, do not make their appearance till some time after. This species inhabits Europe, and is found in damp places and in nuts. The juli tribe are nearly allied to the scolopendræ, or centipedes, but their body, instead of being flattened, as in those insects, is nearly cylindrical, and every joint or segment is furnished with two pair of feet, the number on each side doubling that of the segments, but in the scolopendræ the number of joints and of feet is equal on each side. The eyes of the juli are composed of hexagonal convexities, as in most of the insect tribe, and the mouth is furnished with a pair of denticulated jaws. When disturbed, the

juli roll themselves up into a flat spiral: their general motion is rather slow and undulatory.

JUNCUS, in botany, *rush*, a genus of the Hexandria Monogynia class and order. Natural order of Tripetaloideæ. Junci, Jussieu. Essential character: calyx six-leaved; corolla none; capsule one-celled. There are twenty-nine species. The rushes have a simple grassy stem, without leaves or knots, or else knotty, with a sheathing leaf at each knot; flowers terminating or lateral, corymbed or panicled, with the branchlets spathaceous at the base.

These plants agree with the grasses in the glumes of their flowers, and the sheaths of their leaves; they differ in having the stems filled with pith, whereas in grasses it is hollow. The rushes form an intermediate link between the grasses and some of the liliaceous plants, as anthericum, &c.

They form naturally two divisions, one without leaves allied to scirpus, &c. and the other with leafy stems. But all classical botanical writers, says Dr. Smith, have judiciously preserved this very natural genus entire, notwithstanding the capsule is in some species one celled, in others three celled. The sea rushes are planted on the sea-banks in Holland; the roots running deep into the sand, and matting very much, so as to hold it together. In the summer, when they are full grown, they cut them, and when dry, work them into baskets.

JUNGERMANNIA, in botany, so named from Louis Jungermannus of Leipsic, Professor of Botany at Atorff, a genus of the Cryptogamia Algæ, Linnæus, class and order. Natural order of Hepaticæ, Jussieu. Thirty species of these mosses are arranged in five subdivisions, in the fourteenth edition of "Systema Vegetabilium." Dr. Withering has forty-eight species in the third edition of his "Arrangement of British Plants;" he says many of them are beautiful microscopic objects.

JUNGIA, in botany, so named from Joachim Jungius, M. D. a genus of the Syngenesia Polygamia Segregata class and order. Natural order of Compositæ Oppositifoliæ. Cinarocephalæ, Jussieu. Essential character: calyx common, three flowered; receptacle chaffy; florets tubular, two-lipped; outer lip ligulate; inner two-parted. There is but one species, *viz.* J. ferruginea, the stems of which are woody, covered with a ferruginous down; leaves alternate, five-lobed, cordate at the base; lobes rounded, blunt; they are hirsute, and underneath hoary; panicle terminating, large, decompounded; heads of flowers small, heaped. It is a native of South America.

JUNIPERUS, in botany, *juniper-tree*, a genus of the Dioecia Monadelphia class and order. Natural order of Coniferæ. Essential character; male, calyx of the ament a scale; corolla none; stamina three: female, calyx three-parted; petals three; styles three; berry three-seeded, irregular with the three tubercles of the calyx. There are twelve species; some of these are lofty handsome trees; but the J. communis, common juniper, is a low shrub, seldom more than three feet in height, sending out many spreading tough branches, inclining on every side, covered with a brown or reddish bark, with a tinge of purple. The male flowers are sometimes on the same plant with the females, but at a distance from them; they are commonly on distinct plants. The female flowers are succeeded by roundish berries, which are at first green, and when ripe are of a dark purple colour. They continue on the bush two years, and are sessile in the axil of the leaves. Juniper is common in all the northern parts of Europe, in fertile or barren soils, on hills or in valleys, in open sandy plains, or in moist and close woods. In England it is found chiefly on open downs, in a chalky or sandy soil.

IVORY, a hard, solid, and firm substance, of a white colour, and capable of a very good polish. It is the tusk of the elephant, and is hollow from the base to a certain height. It is brought to us from the East Indies, and from the coast of Guinea. Tusks are valuable in proportion to their size; and it is observed, that the Ceylon ivory, and that from the island of Achem, do not become yellow by wear, as all other ivory does: hence the teeth of these places bear a larger price than those of the coast of Guinea.

Ivory *black*, is prepared from ivory, or bones burnt in a close vessel. This, when finely ground, forms a more beautiful and deeper colour than lamp-black; but, in the common methods of manufacturing, it is apt to be adulterated with charcoal dust, so as to be almost, or altogether, unfit for use.

JUPITER, ♃, in astronomy, one of the superior planets, remarkable for its great brightness. See Astronomy.

Jupiter is the brightest of all the planets, except Venus. He moves from west to east in a period of 4332 days, exhibiting irregularities similar to those of Mars. Before he comes into opposition, and when distant from the sun about 115°, his motion becomes retrograde, and increases in

swiftness till he comes in opposition. The motion then becomes gradually slower, and becomes direct when the planet advances within 115° of the sun. The duration of the retrograde motion is about 121 days, and the arch of retrogradation described is about 10°. But there is a considerable difference both in the amount and in the duration of this retrograde motion.

Jupiter has the same general appearance with Mars, only that the belts on his surface are much larger and more permanent. They are said to have been first discovered by Fontana and two other Italians; but Cassini was the first who gave a good account of them. Their number is very variable, as sometimes only one, and at others no fewer than eight, may be perceived. They are generally parallel to one another, but not always so; and their breadth is likewise variable, one belt having been observed to grow narrow, while another in its neighbourhood has increased in breadth, as if the one had flowed into the other, and in this case Dr. Long observes, that a part of an oblique belt lay between them, as if to form a communication for this purpose. The time of their continuance is very uncertain, sometimes remaining unchanged for three months; at others, new belts have been formed in an hour or two. In some of these belts large black spots have appeared, which moved swiftly over the disk from east to west, and returned in a short time to the same place; from whence the rotation of this planet about its axis has been determined.

The figure of Jupiter is evidently an oblate spheroid, the longest diameter of his disk being to the shortest as 13 to 12. His rotation is from west to east, like that of the sun, and the plane of his equator is very nearly coincident with that of his orbit; so that there can scarcely be any difference of seasons in that planet. His rotation has been observed to be somewhat quicker in his aphelion than his perihelion. The axis of rotation is nearly perpendicular to the plane of the ecliptic, and the planet makes one revolution in about 9^{h}. 55′ and 37″. The changes in the appearances of these spots, and the difference in the time of their rotation, make it probable that they do not adhere to Jupiter, but are clouds transported by the wind, with different velocities, in an atmosphere subject to violent agitations.

Four little stars are observed around Jupiter, which constantly accompany him. Their relative situation is continually changing. They oscillate on both sides of the planet, and their relative rank is determined by the length of these oscillations. That one in which he oscillation is shortest is called the firs satellite, and so on. These satellites are analogous to our moon. See Astronomy. They are all supposed to move in ellipses; though the eccentricities of all of them are too small to be measured, excepting that of the fourth; and even this amounts to no more than 0.007 of its mean distance from the primary.

The orbits of these planets were thought by Galileo to be in the same plane with that of their primary: but M. Cassini has found that their orbits make a small angle with it; and as he did not find any difference in the place of their nodes, he concluded that they were all in the same place, and that their ascending nodes were in the middle of Aquarius. After observing them for more than thirty-six years, he found their greatest latitude, or deviation from the plane of Jupiter's orbit, to be 2° 55′. The first of these satellites revolves at the distance of 5.697 of Jupiter's semi-diameters, or 1′ 51″, as measured by proper instruments; its periodical time is 1^{d}. 18^{h}. 27′ 34″. The next satellite revolves at the distance of 9.017 semi-diameters, or 2′ 56″, in 3^{d}. 13^{h}. 13′ 43″; the third at the distance of 14.384 semi-diameters, or 4′ 42″, in 7^{d}. 3^{h}. 42′ 36″; and the fourth at the distance of 25.266, or 8′ 16″, in 16^{d}. 16^{h} 32′ 09″. Since the time of Cassini it has been found that the nodes of Jupiter's satellites are not in the same place; and from the different points of view in which we have an opportunity of observing them from the earth, we see them sometimes apparently moving in straight lines, and at other times in elliptic curves. All of them, by reason of their immense distance, seem to keep near their primary, and their apparent motion is a kind of oscillation, like that of a pendulum; going alternately from their greatest distance on one side to the greatest distance on the other, sometimes in a straight line, and sometimes in an elliptic curve.

When a satellite is in its superior semicircle, or that half of its orbit which is more distant from the earth than Jupiter is, its motion appears to us direct, according to the order of the signs; but in its inferior semi-circle, when it is nearer to us than Jupiter, its motion appears retrograde; and both these motions seem quicker the nearer the satellites are to

the centre of the primary, slower the more distant they are, and at the greatest distance of all they appear for a short time to be stationary.

From this account of the system of Jupiter and his satellites, it is evident that occultations of them must frequently happen by their going behind their primary, or by coming in betwixt us and it. The former takes place when they proceed towards the middle of their upper semicircle; the latter, when they pass through the same part of their inferior semi-circle. Occultations of the former kind happen to the first and second satellites; at every revolution, the third very rarely escapes an occultation; but the fourth more frequently, by reason of its greater distance.

It is seldom that a satellite can be discovered upon the disk of Jupiter, even by the best telescopes, excepting at its first entrance, when, by reason of its being more directly illuminated by the rays of the sun than the planet itself, it appears like a lucid spot upon it. Sometimes, however, a satellite in passing over the disk appears like a dark spot, and is easily to be distinguished. This is supposed to be owing to spots on the body of these secondary planets; and it is remarkable, that the same satellite has been known to pass over the disk at one time as a dark spot, and at another so luminous that it could not be distinguished from Jupiter himself, except at its coming on and going off. When the satellites pass through their inferior semi-circles, they may cast a shadow upon their primary, and thus cause an eclipse of the sun to his inhabitants, if there are any; and in some situations this shadow may be observed going before or following the satellite. On the other hand, in passing through their superior semicircles, the satellites may be eclipsed in the same manner as our moon, by passing through the shadow of Jupiter; and this is actually the case with the first, second, and third of these bodies: but the fourth, by reason of the largeness of its orbit, passes sometimes above or below the shadow, as is the case with our moon.

The beginnings and endings of these eclipses are easily seen by a telescope, when the earth is in a proper situation with regard to Jupiter and the sun; but when this or any other planet is in conjunction with the sun, the superior brightness of that luminary renders both it and the satellites invisible. From the time of its first appearing after a conjunction, until near the opposition, only the immersions of the satellites into his shadow, or the beginnings of the eclipses, are visible; at the opposition, only the occultations of the satellites, by going behind or coming before their primary, are observable: and from the opposition to the conjunction, only the immersions, or end of the eclipses, are to be seen. This is exactly true in the first satellite, of which we can never see an immersion with its immediately subsequent emersion: and it is but rarely that they can be both seen in the second; as, in order to their being so, that satellite must be near one of its limits, at the same time that the planet is near his perihelion and quadrature with the sun. With regard to the third, when Jupiter is more than forty-six degrees from conjunction with, or opposition to the sun, both its immersions and immediately subsequent emersions are visible; as they likewise are in the fourth, when the distance of Jupiter from conjunction or opposition is twenty-four degrees.

JURATS, magistrates in the nature of Aldermen, for the government of several corporations. Thus we meet with the Mayor and Jurats of Maidstone, Rye, &c.

JURY, a certain number of persons sworn to inquire of and try some matter of fact, and to declare the truth upon such evidence as shall be laid before them. The jury are sworn judges upon all evidence in any matter of fact. Juries may be divided into two kinds, common and special. A common jury is such as is returned by the sheriff, according to the directions of the statute 3 George II. cap. 25, which appoints that the sheriff's officer shall not return a separate pannel for every separate cause, but one and the same pannel for every cause to be tried at the same assizes, containing not less than forty-eight, nor more than seventy-two jurors; and their names being written on tickets shall be put into a box or glass, and when each cause is called, twelve of those persons, whose names shall be first drawn out of the box, shall be sworn upon a jury, unless absent, challenged, or excused. When a sufficient number of persons are impannelled, they are then separately sworn well and truly to try the issue between the parties, and a true verdict give according to the evidence.

Special juries were originally introduced in trials at bar, when the causes were of too great nicety for the discussion of

ordinary freeholders. To obtain a special jury, a motion is made in court, and a rule is granted thereupon, for the sheriff to attend the master, prothonotary, or other proper officer, with his freeholder's book, and the officer is to take indifferently forty-eight of the principal freeholders, in the presence of the attornies on both sides, who are each of them to strike off twelve, and the remaining twenty-four are returned upon the pannel.

Jurors are punishable for sending for, or receiving instructions from, either of the parties concerning the matter in question.

In causes of nisi prius, every person whose name shall be drawn, and who shall not appear after being openly called three times, shall, on oath made of his having been lawfully summoned, forfeit a sum not exceeding *5l.* nor less than *40s.*, unless some reasonable cause of absence be proved, by oath or affidavit, to the satisfaction of the judge. If any juror shall take of either party to give his verdict, he shall, on conviction, by bill or plaint, before the court where the verdict shall pass, forfeit ten times as much as he has taken; half to the King, and half to him who shall sue. A man who shall assault or threaten a juror for giving a verdict against him, is highly punishable by fine and imprisonment; and if he strike him in the court, in the presence of the judge of assize, he shall lose his hand and his goods, and the profits of his lands during life, and suffer perpetual imprisonment.

JURY *mast*, whatever is set up in room of a mast that has been lost in a storm or in an engagement, and to which a lesser yard, ropes, and sails, are fixed.

JUSSIÆA, in botany, so named from Antoine de Jussieu, a genus of the Decandria Monogynia class and order. Natural order of Calycanthemæ. Onagræ, Jussieu. Essential character: calyx four or five parted, superior; petals four or five; capsules four or five celled, oblong, gaping at the corners; seeds numerous, minute. There are eleven species. These are mostly herbaceous plants, natives of North and South America, also of the East and West Indies.

JUSTICE signifies he who is deputed by the King to do right by way of judgment.

Justices *in eyre*, in ancient times, were sent with commission into several counties, to hear such causes especially as were termed pleas of the crown. And this was done for the ease of the people, who must otherwise have been hurried to the King's Bench, if the case were too high for the county court: they differed from the justices of oyer and terminer, because they were sent upon one or for special causes, and to one place; whereas the justices in eyre were sent through the province and counties of the land, with more indefinite and general commissions.

Justices *of gaol delivery*, such as are sent with commission to hear and determine all causes appertaining to such as for any offence are cast into the gaol.

Justices *of nisi prius*, are the same with justices of assize, for it is a common adjournment of a cause, to put it off to such a day, *nisi prius justiciarii venerint ad eas partes ad capiendas assisas;* and upon this clause of adjournment, they are called justices of *nisi prius*, as well as justices of assize, by reason of the writ or action they have to deal in.

Justices *of oyer and terminer*. As the justices of assize and *nisi prius* are appointed to try civil cases, so are the justices of oyer and terminer, and gaol delivery, to try indictments for all crimes all over the kingdom, at what are generally denominated the circuits or assizes; and the towns where they come to execute their commission are called the assize towns, and are generally the county towns.

Justices *of the peace*, are persons appointed by the King's commission, to attend to the peace of the county where they dwell. They were called guardians of the peace till the thirty-sixth year of Edw. III. c. 12, where they are called justices. A justice of the peace must, before he acts, take the oath of office, which is usually done before some persons in the county, by virtue of a *dedimus potestatem* out of chancery. Sheriffs, coroners, attorneys, and proctors, may not act as justices of the peace.

The power, office, and duty of this magistrate extends to an almost infinite number of instances, specified in some hundreds of acts of parliament, and every year accumulating. The commission of of the peace does not determine by the demise of the King, nor until six months after, unless sooner determined by the successor: but before his demise, the King may determine it, or may put out any particular person, which is most commonly done by a new commission, leaving out such person's name.

Justices of the peace can only be appointed by the king's special commission,

and such commission must be in his name; but it is not requisite that there should be a special suit or application to, or warrant from the King for the granting it, which is only requisite for such as are of a particular nature, as constituting the mayor of such a town and his successors perpetual justices of the peace within their liberties, &c. which commissions are neither revocable by the King, nor determinable by his demise, as the common commission of the peace is, which is made of course by the Lord Chancellor according to his discretion.

The form of the commission of the peace, as it is at this day, was, according to Hawkins, settled by the judges about 23 Elizabeth.

Justices of the peace have no power to hear and determine felonies, unless they are authorised so to do by the express words of their commissions; and that their jurisdictions to hear and determine murder, man-slaughter, and other felonies and trespasses is by force of the express words in their commission.

But though justices of the peace, by force of their commission, have authority to hear and determine murder and manslaughter, yet they seldom exercise a jurisdiction herein, or in any other offences in which clergy is taken away, for two reasons: 1. By reason of the monition and clause in their commission, *viz.* in cases of difficulty to expect the presence of the justices of assize. 2. By reason of the direction of the statute of 1 and 2 Philip and Mary, c. 13, which directs justices of the peace, in case of manslaughter and other felonies, to take the examination of the prisoner, and the information of the fact, and put the same in writing, and then to bail the prisoner if there be cause, and to certify the same with the bail, at the next general gaol delivery; and therefore in cases of great moment they bind over the prosecutors, and bail the party, if bailable, to the next general gaol delivery; but in smaller matters, as petty larceny, and in some other cases, they bind over to the sessions; but this is only in point of discretion and convenience, not because they have not jurisdiction of the crime.

As to inferior offences, the jurisdiction herein given to justices of the peace, by particular statutes, is so various, and extends to such a multiplicity of cases, that it would be endless to endeavour to enumerate them; also they have as justices of the peace a very ample jurisdiction in all matters concerning the peace. And therefore not only assaults and batteries, but libels, barratry, and common nightwalking, and haunting bawdy-houses, and such like offences, which have a direct tendency to cause breaches of the peace, are cognizable by justices of the peace, as trespasses within the proper and natural meaning of the word.

On renewing the commission of the peace (which generally happens when any person is newly brought into it) a writ of *dedimus potestatem* is issued out of chancery, to take the oath of him who is newly inserted, which is usually in a schedule annexed, and to certify the same into that court at such a day as the writ commands. Unto which oath are usually annexed the oaths of allegiance and supremacy.

Justices of the peace are to hold their sessions four times in the year, *viz.* the first week after Michaelmas, the Epiphany, Easter, and St. Thomas. They are justices of record, for none but justices of record can take a recognizance of the peace. Every justice of the peace has a separate power, and may do all acts concerning his office apart and by himself; and even may commit a fellow justice upon treason, felony, or breach of the peace. By several statutes, justices may act in many cases where their commission does not reach; the statutes themselves being a sufficient commission.

Justices of the peace are authorized to do all things appertaining to their office, so far as they relate to the laws for the relief, maintenance, and settlement of the poor; for passing and punishing vagrants; for repair of the highways, or to any other laws concerning parochial taxes, levies, or rates: notwithstanding they are rated or chargeable with the rates, within any place affected by such their acts. Provided that this shall not empower any justice for any county at large, to act in the determination of any appeal to the quarter sessions of such county, from any order, matter, or thing, relating to any such parish, township, or place, where such justice is so charged or chargeable, 16 Geo. II. c. 18 The power of justices is ministerial, when they are commanded to do any thing by a superior authority, as the court of Banco Regis, &c. In all other cases they act as judges; but they must proceed according to their commission, &c. Where a statute requires an act to be done by two justices, it is an established rule, that if

the act be of a judicial nature, or the result of discretion, the two justices must be present, to concur and join in it, otherwise it wi· be void: as in the orders of removal and filiation, the appointment of overseers, and the allowance of the indenture of a parish apprentice; but where the act is merely ministerial, they may act separately, as in the allowance of a poor-rate. This is the only act of two justices which has been construed to be ministerial; and the propriety of this construction has been justly questioned.

Where a justice shall exceed his authority in granting a warrant, the officer must execute it, and he is indemnified for so doing; but if it be in a case wherein he has no jurisdiction, or in a matter whereof he has no cognizance, the officer ought not to execute such warrant; for the officer is bound to take notice of the authority and jurisdiction of the justice. If a justice of the peace will not, on complaint to him made, execute his office, or if he shall misbehave in his office, the party grieved may move the Court of King's Bench for an information, and afterwards may apply to the Court of Chancery to put him out of the commission. But the most usual way of compelling justices to execute their office, in any case, is by writ of mandamus out of the Court of King's Bench.

Where the plaintiff in an action against a justice, shall obtain a verdict, and the judge shall in open court certify on the back of the record, that the injury for which such action was brought was wilfully and maliciously committed, the plaintiff shall have double costs. And if a justice of peace act improperly, knowingly, information shall be granted. No justice shall be liable to be punished both ways, that is, criminally and civilly; but before the court will grant an information, they will require the party to relinquish his civil action, if any such be commenced. And even in the case of an indictment, and though the indictment be actually found, the Attorney-General, on application made to him, will grant a *noli prosequi* upon such indictment, if it appear to him that the prosecutor is determined to carry on a civil action at the same time.

If any action shall be brought against a justice for any thing done by virtue of his office, he may plead the general issue, and give the special matter in evidence; and if he recover, he shall have double costs. Such action shall not be laid but in the county where the fact was committed. And no suit shall be commenced against a justice of the peace till after one month's notice. And unless it is proved upon the trial that such notice was given, the justice shall have a verdict and costs. And no action shall be brought against any constable or other officer, or any person acting by his order and in his aid, for any thing done in obedience to the warrant of a justice, till demand hath been made, or left at the usual place of his abode, by the party or by his attorney, in writing, signed by the party demanding the same, of the perusal and copy of such warrant, and the same has been refused or neglected for six days after such demand. And no action shall be brought against any justice, for any thing done in the execution of his office, unless commenced within six months after the act committed.

JUSTICIA, in botany, so named from James Justice, a genus of the Diandria Monogynia class and order. Natural order of Personatæ. Acanthi, Jussieu. Essential character: corolla ringent; capsule two-celled, opening with an elastic claw; stamina with a single anther. There are eighty species, mostly natives of the Cape of Good Hope and the East Indies. There are only two commonly known in our English gardens, *viz.* J. adhatodar, Malabar nut; and J. hyssopifolia, snap tree.

JUSTICIES is a writ directed to the sheriff to do justice in a plea of trespass *vi et armis*, or of any sum above 40s. in the county court, of which he hath no cognizance by ordinary power. It is in the nature of a commission to the sheriff, and is not returnable.

IXIA, in botany, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: corolla one-petalled, tubular; tube straight, filiform; border six-parted, bell-shaped, regular; stigmas three or six, simple. There are fifty-four species. Ixia differs from antholyza in having the segments of the corolla nearly equal; from gladiolus, in the situation of the segments of the corolla, and in having the tube straight. Almost all the species are natives of the Cape of Good Hope.

IXORA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: corolla one-petalled, funnel-form, long, superior; stamina above the mouth; berry four-seeded. There are nine species, of which I. Americana, American ixora, has a shrubby stalk, four or five feet high, send-

ing out slender opposite branches; leaves nearly six inches long, on short foot stalks. Flowers at the ends of the branches in a loose spike, they are white, and have a scent like jasmine, whence in Jamaica, and other islands of the West Indies, where it is a native, it is called wild jasmine.

K.

K, Or k, the tenth letter, and seventh consonant of our alphabet; being formed by the voice, by a guttural expression of the breath through the mouth, together with a depression of the lower jaw, and opening of the teeth.

Its sound is much the same with that of the hard *c*, or *qu*; and it is used, for the most part, only before *e*, *i*, and *n*, in the beginning of words; as, *ken*, *kill*, *know*, &c. It used formerly to be always joined with *c* at the end of words, but is at present very properly omitted: thus, for *publick*, *musick*, &c. we say, *public*, *music*, &c. However, in monosyllables it is still retained, as *jack*, *block*, *mock*, &c.

The letter *k* is derived from the Greek kappa, K or κ; it being unknown to the Romans, though we sometimes meet with kalendæ instead of calendæ.

As a numeral, K denotes 250; and with a line over it, $\bar{K}$ 250,000.

KÆMPFERIA, in botany, so named from Engelbert Kæmpfer, a celebrated traveller, a genus of the Monandria Monogynia class and order. Natural order of Scitamineæ. Cannæ, Jussieu. Essential character: corolla six-parted, three of the parts larger, spreading, one two-parted; stigma two-plated. There are two species, *viz.* K. galanga, galangale; and K. rotunda. As these are both natives of the East Indies, they require a warm stove to preserve them through our winter.

KALI. See Alkali and Potash.

KALMIA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Bicornes. Rhododendra, Jussieu. Essential character: calyx five-parted; corolla salver-form, with the border five-horned beneath; capsule five-celled. There are four species; of the K. latifolia, broad-leaved kalmia, we shall give some little account, taken from the fifth volume of the American Philosophical Transactions. The leaves of this shrub are feasted upon by the deer and the round horned elk, but are mortally poisonous to sheep, to horned cattle, to horses, and to man. The bee extracts honey, without injury, from its nectary, but the man who partakes of that honey, after it is deposited in the hive cells, falls a victim to his repast.

Some very singular cases, in proof of this assertion, occurred at Philadelphia no longer ago than the year 1790, in the autumn and winter of which an extensive mortality was produced amongst those who had partaken of the honey that had been collected in the neighbourhood of Philadelphia, or had feasted on the common American pheasant. The attention of the American government was excited by the general distress, a minute examination into the cause of the mortality ensued, and it was satisfactorily ascertained, that the honey had been chiefly extracted from the flowers of kalmia latifolia, and that the pheasants, which had proved thus poisonous, had fed harmlessly on its leaves: in consequence of which, a public proclamation was issued, prohibiting the use of the pheasant, as a food, for that season. See Good's Oration before the Medical Society.

KAMSIN, the name of a hot southerly wind, common in Egypt. The wind is said to prevail more or less for fifty days, hence it is called "the wind of fifty days." Travellers, who have experienced the effect of it, have described it as a poisonous wind. When it begins to blow, the atmosphere assumes an alarming appearance. The sky, at other times so clear in this climate, becomes dark and heavy; the sun loses its splendour, and appears of a violet colour; the air is not cloudy, but grey and thick, and is filled with a dust so subtile, that it penetrates every where.

This wind, always light and rapid, is not at first remarkably hot, but it increases in heat in proportion as it continues. All animated bodies soon discover it by the change it produces in them. The lungs, which a too rarefied air no longer expands,

are contracted, and become painful. Respiration is short and difficult, the skin parched and dry, and the body consumed by an internal heat. In vain is recourse had to large draughts of water; nothing can restore perspiration. In vain is coolness sought for; all bodies, in which it is usual to find it, deceive the hand that touches them. Marble, iron, water, notwithstanding the sun no longer appears, are hot. The streets are deserted, and the dead silence of night reigns every where. The inhabitants of towns and villages shut themselves up in their houses, and those of the desert in their tents, or in wells dug in the earth, where they wait the termination of this destructive heat. It usually lasts three days, but if it exceeds that time it becomes insupportable. The danger is most imminent when it blows in squalls; for then the rapidity of the wind increases the heat to such a degree as to cause sudden death. This death is a real suffocation. The lungs being empty are convulsed, the circulation is disordered, and the whole mass of blood driven by the heat towards the head and breast; whence the hæmorrhage at the nose and mouth, which happens after death. This wind is especially destructive to persons of a plethoric habit, and those in whom fatigue has destroyed the tone of the muscles and the vessels. The corpse remains a long time warm, swells, turns blue, and soon becomes putrid. These accidents are to be avoided by stopping the nose and mouth with handkerchiefs. An efficacious method, likewise, is that practised by the camels. On this occasion these animals bury their noses in the sand, and keep them there till the squall is over. Another quality of this wind is its extreme aridity; which is such, that water sprinkled on the floor evaporates in a few minutes. By the extreme dryness it withers and strips all the plants; and by exhaling too suddenly the emanations from animal bodies, crisps the skin, closes the pores, and causes that feverish heat which is the constant effect of suppressed perspiration.

KAOLIN, in the arts, the name of an earth used in the manufacture of oriental porcelain china. A specimen of this earth was brought from China, and examined by Reaumur, who found it to be infusible by fire. He thought it was a talcy earth; but Mr. Macquer says it is more probably of an argillaceous nature, from its forming a tenacious paste, with the other ingredient called petunse, which has no tenacity. A French chemist, M. Bomaire, analyzed it, and found it was a compound earth, consisting of clay, to which it owed its tenacity; of calcareous earth, which gave it a mealy appearance; of sparkling crystals of mica; and of small gravel, or particles of quartz-crystals. He found a similar earth upon a stratum of granite, and conjectures it may be a decomposed granite.

KEDGING, in the sea-language, is when a ship is brought up or down a narrow river by means of the tide, the wind being contrary. To do this, they use to set their fore-course, or fore-top-sail and mizen, that so they may flat her about; and if she happen to come too near the shore, they let fall a kedge-anchor, with a hawser fastened to it from the ship, in order to turn her head about; which work is called kedging.

KEEL, the lowest piece of timber in a ship, running her whole length, from the lower part of her stem to the lower part of her stern-post. Into it are all the lower futtocks fastened; and under part of it a false keel is often used.

By comparing the carcass of a ship to the skeleton of a human body, the keel appears as the back bone, and the timbers as the ribs. Accordingly, the keel supports and unites the whole fabric, since the stem and stern-posts, which are elevated on its ends, are, in some measure, a continuation of the keel, and serve to connect and inclose the extremities of the sides by transoms, as the keel forms and unites the bottom by timbers.

The keel is generally composed of several thick pieces placed lengthways, which, after being scarfed together, are bolted and clinched upon the upper side.

Keel *hauling*, a punishment inflicted for various offences in the Dutch navy. It is performed by suspending the culprit by a rope from one yard arm, with a weight of lead or iron upon his legs, and having another rope fastened to him, leading under the ship's bottom, and through a block at its opposite yard-arm; he is then repeatedly and suddenly let fall from the one yard-arm into the sea, where, passing under the ship's bottom, he is hoisted upon the opposite side of the vessel to the other.

KEELERS, among seamen, are small tubs, which hold stuff for the caulking of ships.

KEELSON, a principal timber in a ship, fayed within-side cross all the floor-timbers; and being adjusted to the keel with suitable scarfs, it serves to strengthen the bottom of the ship.

KEEP, in ancient military history, a kind of strong tower, which was built in

the centre of a castle or fort, to which the besieged retreated, and made their last efforts of defence.

Of this description is the keep of Windsor Castle.

KEEPER *of the great seal*, is a lord by virtue of his office, and styled the Lord Keeper of the Great Seal of England. He is one of the King's Privy Council, through whose hands pass all charters, commissions, and grants of the King under the great seal; without which, all such instruments by law are of no force, the King in this being a corporation, whose acts are evidenced by his seal. This Lord Keeper, by the statue of 5 Elizabeth, cap. 18, has the same place, authority, pre-eminence, &c. as the Lord Chancellor of England for the time being. He is constituted by the delivery of the great seal to him, taking his oath.

KEEPER *of the privy seal*, is a lord by virtue of his office, through whose hands pass all charters signed by the King before they come to the great seal. He is of the King's Privy Council, and was anciently called Clerk of the Privy Seal.

KEEPING, in painting, signifies the representation of objects in the same manner that they appear to the eye at different distances from it, which is only to be done with accuracy by attending to the rules of perspective.

KELP, an impure alkali, obtained in the north of Scotland, from different kinds of fuci, or sea-weed. The sea-weeds being dried, are put in pits dug in the sand, or on the surface, surrounded with loose stone, forming what is called a kiln, fresh quantities being added, and the whole being frequently stirred until it become semi-fluid, which, when cold, forms hard masses.

KELP, a fixed salt, or particular species of a potash, procured by burning the weed called kali.

KERMES, in natural history, a species of the Coccus, which see.

KERMES *mineral*, in chemistry, an antimonial compound of great celebrity as a medicine about the beginning of the seventeenth century; in the new chemical arrangement it is denominated hydro-sulphuret of antimony.

The substance is prepared in the following manner: sixteen parts of sulphuret of antimony, eight parts of potash, and one of sulphur, are triturated together in a mortar, melted in a crucible, and the mass poured into an iron vessel. When cold it is pounded, and boiled in a sufficient quantity of water, and the solution is filtered while hot. On cooling, it deposits the kermes abundantly in the state of a yellow powder, which is edulcorated with a sufficient quantity of water, and dried. The true kermes consists of

Sulphuretted hydrogen	20.30
Sulphur	4.15
Protoxide of antimony	72.76
Water, and loss	2.79
	100.00

KETCH, a vessel equipped with two masts, *viz.* the main-mast and the mizen-mast, and usually from 100 to 250 tons burthen. Ketches are principally used as yachts for conveying princes of the blood, ambassadors, or other great personages, from one place to another. Ketches are likewise used as bomb-vessels, and are therefore furnished with all the apparatus necessary for a vigorous bombardment.

KETCHES, *bomb*, are built remarkably strong, as being fitted with a greater number of riders than any other vessel of war; and indeed this reinforcement is absolutely necessary to sustain the violent shock produced by the discharge of their mortars, which would otherwise in a very short time shatter them to pieces.

KEY, a well known instrument for opening and shutting the locks of doors, chests, &c. See LOCK.

KEY, or *key note*, in music, a certain fundamental note or tone, to which the whole of a movement has a certain relation or bearing, to which all its modulations are referred and accommodated, and in which it both begins and ends. There are but two species of keys: one of the major, and one of the minor mode: all the keys in which we employ sharps or flats being deduced from the natural keys of C major and A minor; of which they are mere transpositions.

KEYS *of an organ*, those moveable, projecting levers in the front of an organ, so placed as to conveniently receive the fingers of the performer, and which, by a connected movement with the valves or pallets, admit or exclude the wind from the pipes. When a single key of an organ is pressed down, as many sounds are heard as all the stops which are then out furnish to that key; in other words, all those pipes are heard which are permitted by those stops and that key to receive the wind.

KEY *stone* of an arch or vault, that placed at the top or vertex of an arch, to bind the two sweeps together. This, in the Tuscan and Doric orders, is only a plain stone, projecting a little; in the

Ionic it is cut and waved somewhat like consoles; and in the Corinthian and Composite orders it is a console, enriched with sculpture. Keystones, made in the manner of consoles, and placed projecting in the middle of arches and porticos, are particularly designed to sustain the weight and pressure of the entablature, where it happens to be very great between the columns; for which reason, they should be made so as to be a real support, and not stand for mere ornaments, as they too frequently do.

KIDNAPPING, is the forcibly taking and carrying away a man, woman or child, from their own country, and sending them to another. This is an offence at common law, and punishable by fine, imprisonment, and pillory. By statute 11 and 12 William III. c. 7, if any captain of a merchant vessel shall, during his being abroad, force any person on shore, and wilfully leave him behind, or refuse to bring home all such men as he carried out, if able and desirous to return, he shall suffer three months imprisonment. Exclusive of the above punishment for this, as a criminal offence, the party may recover upon an action for compensation in damages for the civil injury.

KIGGELARIA, in botany, so named from Francis Kiggelar of Holland, a genus of the Dioecia Decandria class and order. Natural order of Columniferæ. Euphorbiæ, Jussieu. Essential character: male, calyx five-parted; corolla five-petalled; glands five, three-lobed; anthers perforated at the tip: female, calyx and corolla as in the male; styles five; capsule one-celled, five valved, many-seeded. There is but one species, *viz.* K. africana. This plant grows naturally at the Cape of Good Hope, where it rises to a tree of middling stature; the branches have a smooth bark, which is at first green, afterwards it changes to a purplish colour: the leaves are about three inches long and one broad, sawed on their edges, standing upon short footstalks alternately. The flowers come out in clusters from the side of the branches, hanging downwards; they are of an herbaceous white colour, appearing in May, at which time the plants are thinly garnished with leaves, most of the old ones dropping off just before the new leaves appear. The male flowers fall away soon after their farina is shed; but the hermaphrodite, or female flowers, are succeeded by globular fruit, the size of common red cherries; the cover of these is very rough, and of a thick consistence, opening in five valves at the top, having one cell filled with small angular seeds. These fruits have grown to their full size in the Chelsea garden; but the seeds have rarely come to maturity.

KILDERKIN, a liquid measure, containing two firkins, or eighteen gallons.

KING *of England*. The executive power in England is vested in a single person by immemorial usage, to whom the care of the people is entrusted, and to whom, therefore, allegiance is due. Formerly, the succession being interrupted, there was occasionally a distinction between a rightful king, or king *de jure*, and a king in possession of the throne, or king *de facto*; and in cases of treason, and also with respect to many acts done by kings *de facto*, which were necessary to be recognised by kings *de jure* afterwards, this distinction was of great importance: but it seems now only necessary to consider the rightful power and authority of the King, lawfully and peaceably in possession of the throne. And in this country the crown is by common law hereditary in a peculiar manner, but not *de jure divino*; and it may be changed in the limitation of its descent by the authority of the King, Lords, and Commons, in parliament assembled, but it is not elective. As to the mode of inheritance, it is generally the same as other feodal descents, but it differs in one or two particulars; for it descends regularly to lineal descendants by right of primogeniture: but in case of no male heir, it descends to the eldest daughter only, and to her issue, and not in coparcenary to all the daughters. In failure of lineal heirs it goes to collateral descendants, but there is no failure on account of half blood. Lands also purchased by the King descend with the crown. The inheritance is not indefeasible, but may be altered as above, and therefore the statutes have expressed "his Majesty, his heirs, and successors." But, however limited or transferred, it still retains its hereditable quality to the wearer of it; and hence the King never dies, but his right vests *ea instanti* in his heir; so that Hall says, there can be no interregnum, and the death of the King is called the demise of the crown, which ordinarily means only a transfer from one to another. If the throne becomes vacant, whether by abdication, as in the time of James II., or by failure of all heirs, the two houses of parliament may, it is said by Blackstone, dispose of it.

The preamble to the bill of rights expressly declares, that the lords spiritual and temporal, and commons, assembled at Westminster, lawfully, fully, and freely represent all the estates of the people of the English realm. The lords are not less the trustees and guardians of their country than the members of the House of Commons. It was justly said, when the royal prerogatives were suspended, during his Majesty's illness in 1788, that the two houses of Parliament were the organs by which the people expressed their will: and in the House of Commons, on the 16th of December, in that year, two declaratory resolutions were accordingly passed, importing, 1. The interruption of the royal authority; 2. That it was the duty of the two Houses of Parliament to provide the means of supplying that defect. On the 23d of the same month a third resolution passed, empowering the Lord Chancellor of Great Britain to affix the great seal to such bill of limitations as might be necessary to restrict the power of the future regent to be named by Parliament. This bill was accordingly brought forward, not without considerable opposition to its provisions, as well from private motives, as on forcible political grounds; and at length, happily for the public, arrested in its progress, by the providential recovery of his Majesty, in March 1789. It is observable, however, that no bill was ever afterwards introduced to guard against a future emergency of a similar nature: on the grounds, undoubtedly, of delicacy to a monarch universally beloved; in the hope of the improbability that such a circumstance should recur in future; and in the confidence of the omnipotence of Parliament, if necessarily called upon again. See Belsham's "Memoirs of George III.," sub. an. 1788–9: and the "Journals of the Lords and Commons."

Towards the end of King William's reign, the King and Parliament thought it necessary to exert their power of limiting and appointing the succession, in order to prevent the vacancy of the throne; which must have ensued upon their deaths, as no further provision was made at the revolution, than for the issue of Queen Mary, Queen Anne, and King William. It had been previously, by the statute 1 William and Mary, stat. 2, c. 2, enacted, that every person who should be reconciled to, or hold communion with, the see of Rome, who should profess the Popish religion, or who should marry a Papist, should be excluded, and for ever incapable to inherit, possess, or enjoy the crown; and that in such case the people should be absolved from their allegiance (to such person), and the crown should desend to such persons, being protestants, as would have inherited the same, in case the person so reconciled, holding communion, professing, or marrying, were naturally dead. To act, therefore, consistently with themselves, and, at the same time, pay as much regard to the old hereditary line as their former resolutions would admit, they turned their eyes on the princess Sophia, Electress and Dutchess Dowager of Hanover: for, upon the impending extinction of the Protestant posterity of Charles I., the old law of legal descent directed them to recur to the descendants of James I.; and the Princess Sophia, being the youngest daughter of Elizabeth, Queen of Bohemia, who was the daughter of James I., was the nearest of the ancient blood-royal, who was not incapacitated by professing the Popish religion. On her, therefore, and the heirs of her body, being protestants, the remainder of the crown, expectant on the death of King William and Queen Anne, without issue, was settled by stat. 12 and 13 William III. c. 2. And at the same time it was enacted, that whosoever should hereafter come to the possession of the crown, should join in the communion of the Church of England, as by law established.

This is the last limitation of the crown that has been made by Parliament; and all the several actual limitations, from the time of Henry VI. to the present, (stated at large in 1 Comm. c. 3.) do clearly prove the power of the King and Parliament to new-model or alter the succession. And indeed it is now again made highly penal to dispute it; for by stat. 6 Anne, c. 7, it is enacted, that if any person maliciously, advisedly, and directly, shall maintain, by writing or printing, that the kings of this realm, with the authority of Parliament, are not able to make laws to bind the crown and the descent thereof, he shall be guilty of high treason; or if he maintains the same only by preaching, teaching, or advised speaking, he shall incur the penalties of a præmunire. The Princess Sophia dying before Queen Anne, the inheritance, thus limited, descended on her son King George I.; and having taken effect in his person, from him it descended to his late Majesty King George II., and from him to his grandson and heir, our present gra-

cious sovereign King George III. Formerly the common stock, from which the heirs to the crown were derived, was King Egbert, then William the Conqueror. In the time of James I., both stocks were united; and, by the abdication of James II., the common stock is the Princess Sophia, and the heirs of her body, being Protestant members of the Church of England, and married to such as are Protestants. This is therefore an hereditary monarchy, duly constituted between the extremes of divine hereditary, indefeasible right, and elective succession.

With respect to the royal family, the first branch considered in the law is the Queen, as to whom, see title QUEEN.

The Prince of Wales, or heir-apparent to the crown, and also his royal consort; and the Princess Royal, or eldest daughter of the King, are likewise peculiarly regarded by the laws. For, by statute 25 Edw. III. to compass or conspire the death of the former, or to violate the chastity of the latter, is as much high treason as to conspire the death of the king, or violate the chastity of the queen. See TREASON.

The heir-apparent to the crown is usually made Prince of Wales and Earl of Chester, by special creation and investiture; but being the king's eldest son, he is, by inheritance, Duke of Cornwall, without any new creation.

The observations in Coke's Reports, however, as well as the words of the statute, it has been remarked, limit the dukedom of Cornwall to the first begotten (rather first born) son of a king of England, and to him only. But although from this it is manifest that a Duke of Cornwall must be the first begotten son of a king, yet it is not necessary that he should be born after his father's accession to the throne. The younger sons and daughters of the king, and other branches of the royal family, were little regarded by the ancient law, except with regard to their state and precedence, which was directed by statute 31 Henry VIII. c. 10; and it was agreed by all the judges, in 1718, that the care and approbation of the marriages of the king's grand-children, as well as of the presumptive heir to the crown, belonged to the king, their grandfather. And now, by statute George III. c. 11, no descendant of the body of king George II. (other than the issue of princesses married into foreign countries) is capable of contracting matrimony, without the previous consent of the king, signified under the Great Seal; and any marriage contracted without such consent, is void, (a marriage accordingly, which had, in fact, taken place abroad, against the provisions of this act, between one of the sons of George III. and an English lady, was dissolved in 1794, by sentence of the Ecclesiastical Court here); but it is provided by the act, that such of the said descendants as are above the age of twenty-five, may, after a twelve month's notice given to the King's Privy Council, contract and solemnize marriage without the consent of the crown, unless both Houses of Parliament shall, before the expiration of the said year, expressly declare their disapprobation of such intended marriage. All persons solemnizing, assisting, or being present at any such prohibited marriage, shall incur the penalties of præmunire.

To assist the king in the discharge of his duties and maintenance of his dignity, and exercise of his prerogative, he has several councils, as the PARLIAMENT, his PEERS, and his PRIVY COUNCIL, which see.

For law matter the judges are his council, as appears by statute 14 Edward III. c. 5, and elsewhere; and therefore, when the King's Council is mentioned, it must be understood secundum subjectam materiam, as where a statute enacts a fine at the king's pleasure, it means the discretion of his judges.

It is in consideration of the duties incumbent on the king by the constitution, that his dignity and prerogative are established by the laws of the land; it being a maxim in the law, that protection and subjection are reciprocal. And these reciprocal duties are most probably what was meant by the convention parliament in 1688, when they declared that king James II. had broken the original contract between king and people. But, however, as the terms of that original contract were in some measure disputed, being alleged to exist principally in theory, and to be only deducible by reason and the rules of natural law; in which deduction, different understandings might very considerably differ; it was, after the revolution, judged proper to declare these duties expressly, and to reduce that contract to a plain certainty. So that whatever doubts might be formerly raised about the existence of such an original contract, they must now entirely cease; especially with regard to every prince who hath reigned since the year 1688.

The principal duty of the king is, to govern his people according to law. And

this is not only consonant to the principles of nature, reason, liberty, and society, but has always been esteemed an express part of the common law of England, even when prerogative was at the highest. But to obviate all doubts and difficulties concerning this matter, it is expressly declared, by statute 12 and 13 William III. c. 2, That the laws of England are the birth-right of the people thereof; and all the kings and queens who shall ascend the throne of this realm, ought to administer the government of the same according to the said laws; and all their officers and ministers ought to serve them respectively, according to the same; and, therefore, all the laws and statutes of this realm for securing the established religion, and the rights and liberties of the people thereof, and all other laws and statutes of the same, now in force, are ratified and confirmed accordingly. See LIBERTIES.

As to the terms of the original contract between king and people, these it seems are now couched in the coronation oath, which, by statute 1 William and Mary, c. 6, is to be administered to every king and queen, who shall succeed to the imperial crown of these realms, by one of the archbishops or bishops in the presence of all the people; who, on their parts, do reciprocally take the oath of allegiance to the crown.

As to the king's prerogatives, revenues, civil list, and authority, see the title PREROGATIVE.

This coronation oath is conceived in the following terms:

The archbishop or bishop shall say, will you solemnly promise and swear to govern the people of this kingdom of England, (*quere* Great Britain. See statute 5 Ann. c. 8, sect. 1. and this dictionary, title Scotland;) and the dominions thereto belonging, according to the statutes in parliament agreed on; and the laws and customs of the same? The king or queen shall say, I solemnly promise so to do.—Archbishop or bishop, Will you to your power cause law and justice, in mercy, to be executed in all your judgments? King or queen, I will. Archbishop or bishop, Will you to the utmost of your power maintain the laws of God, the true profession of the gospel, and the Protestant reformed religion established by the law? and will you preserve unto the bishops and the clergy of this realm, and to the churches committed to their charge, all such rights and privileges as by law do or shall appertain unto them or any of them? King or queen, All this I promise to do. After this, the king or queen, laying his or her hand upon the Holy Gospels, shall say, The things which I have here before promised, I will perform and keep, so help me God. And then shall kiss the book. It is also required, both by the Bill of Rights, 1 William and Mary, statute 2, c. 2, and the act of settlement, 12 and 13 William III. c. 2, that every king and queen, of the age of twelve years, either at their coronation, or on the first day of the first parliament, upon the throne in the House of Peers, (which shall first happen) shall repeat and subscribe the declaration against Popery, according to 30 Charles II. statute 2, c. 1.

The above is the form of the coronation oath, as it is now prescribed by our laws; the principal articles of which appear to be at least as ancient as the mirror of justices, (c. 1. sect. 2.); and even as the time of Bracton. See l. 3. tr. 1. c. 9, the act of union, statute 5 Ann, c. 8, recites and confirms two preceding statutes; the one of the parliament of Scotland, the other of the parliament of England; which enact, the former, that every king, at his accession, shall take and subscribe an oath, to preserve the Protestant religion, and Presbyterian church government in Scotland; the latter, that at his coronation he shall take and subscribe a similar oath to preserve the settlement of the church of England, within England, Ireland, Wales, and Berwick, and the territories thereunto belonging.

KING *at arms*, or *of arms*, an officer who directs the heralds, presides at their chapters, and has the jurisdiction of armory. There are three kings of arms in England, namely, Garter, Clarencieux, and Norroy.

KING, *Garter principal, at arms.* He, among other privileges, marshals the solemnities at the funerals of the prime nobility, and carries the garter to kings and princes beyond sea, being joined in commission with some peer of the kingdom. See GARTER.

KING, *Clarencieux, at arms.* This king (who is next to Garter) is called Clarencieux, from the Duke of Clarence, to whom he first belonged; for Lionel, third son of king Edward III. marrying the daughter and heir to the Earl of Ulster in Ireland, with her had the honour of Clare in the county of Thomond, whereupon he was afterwards created Duke of Clarence, or the territory about Clare; which dukedom escheating to Edward IV. by the death of his brother George Duke of Clarence, (who was secretly murdered

in the Tower of London) he made the herald, who properly belonged to that duke, a king of arms, and named him Clarencieux.

His office is to marshal and dispose of the funerals of all the lesser nobility, as Baronets, Knights of the Bath, Knights Batchelors, Esquires, and Gentlemen, on the south side of the river Trent, and therefore is sometimes called Surroy, or South-Roy.

King, *Norroy, at arms.* The office of this King, (who is called Norroy or North-Roy) is to do the like on all the north side of Trent, as Clarencieux on the south; and these being both provincial Kings of Arms have the whole kingdom of England divided between them; and are created by letters patents, a book, a sword, &c. as Garter, and with almost the same ceremony.

Note. That in the sixth of Edward VI. Bartholomew Butler, York Herald, was created Ulster King of Arms in Ireland, at which time Philip Butler was made Athlone Pursuivant of Arms there; and upon their creation, a warrant was issued to Sir Ralph Sadler, Knight of the King's Wardrobe, to deliver to the said Bartholomew Butler, alias Ulster King of Arms of Ireland, one coat of blue and crimson velvet, embroidered with gold and silver upon the same with the King's Arms; and to the said Philip Butler, Athlone Pursuivant, one coat of sarsnet of the King's colours, with the arms laid on with gold and purple.

King *at arms, Lyon,* for Scotland, is the second king at arms for Great Britain; he is invested and solemnly crowned. He publishes the king's proclamations, marshals funerals, reverses arms, appoints messengers at arms, &c. See College *of heralds.*

KING'S *Bench.* The King's Bench is the supreme court of common law in the kingdom; and is so called because the King used to sit there in person: it consists of a chief justice, and three puisne justices, who are by their office the sovereign conservators of the peace, and supreme coroners of the land. This court has a peculiar jurisdiction, not only over all capital offences, but also over all other misdemeanors of a public nature, tending either to a breach of the peace, or to oppression, or faction, or any manner of misgovernment. It has a discretionary power of inflicting exemplary punishment on offenders, either by fine, imprisonment, or other infamous punishment, as the nature of the crime, considered in all its circumstances, shall require.

The jurisdiction of this court is so transcendant, that it keeps all inferior jurisdictions within the bounds of their authority; and it may either remove their proceedings, to be determined here, or prohibit their progress below: it superintends all civil corporations in the kingdom; commands magistrates and others to do what their duty requires by mandamus, in every case where there is no specific remedy; protects the liberty of the subject, by speedy and summary interposition; and takes cognizance both of criminal and civil causes, the former in what is called the crown side, or crown office; the latter in the plea side of the court. This court has cognizance, on the plea side, of all actions of trespass, or other injury alleged to be committed *vi et armis*; of actions for forgery of deeds, maintenance, conspiracy, deceit; and actions on the case which allege any falsity or fraud. In proceedings in this court the defendant is arrested for a supposed trespass, which in reality he has never committed, and being thus in the custody of the marshal of this court, the plaintiff is at liberty to proceed against him for any other personal injury, which surmise of being in the custody of the marshal the defendant is not at liberty to dispute. This court is likewise a court of appeal, into which may be removed, by writ of error, all determinations of the court of Common Pleas, and of all inferior courts of record in England. It is now usually held at Westminster; but was formerly attendant upon the King's person, and original writs are returnable "wheresoever we (the King) shall then be in England."

KNAPSACK, a rough leather or canvass bag, which is strapped to an infantry soldier's back when he marches, and which contains his necessaries. Square knapsacks are supposed to be most convenient. They should be made with a division to hold the shoes, blacking-balls, and brushes, separate from the linen. White goat-skins are sometimes used; but we do not conceive them to be equal to the painted canvas ones. Soldiers in the British service are put under stoppages for the payment of their knapsacks, which after six years become their property. Knapsack is said to have been originally so called from the circumstance of a soldier making use of a sack which had been full of corn, &c. In those days there were no roads, and every thing was carried on

packhorses. When the soldiers reposed, they hung up the empty sacks, and slept in them. The word should be napsack, from napping, &c. to slumber. The army was supplied by packhorses, and all things were in sacks, so that every soldier had his sack. Such is the account given by a very worthy and respectable friend; but we are inclined to to think that knapsack comes from the Saxon word *snapsack*, a bag to carry food. See James's Dictionary.

KNAUTIA, in botany, so named from Christopher Knaut, a genus of the Tetrandria Monogynia class and order. Natural order of Aggregatæ. Dipsaceæ, Jussieu. Essential character; calyx common oblong, simple, five to ten flowered; corollets irregular; receptacle naked. There are four species, mostly natives of the Levant.

KNEE. See ANATOMY.

KNEE, a crooked piece of timber, having two branches or arms, and generally used to connect the beams of a ship with her sides or timbers. The branches of the knees form an angle of greater or smaller extent, according to the mutual situation of the pieces which they are designed to unite. One branch is securely bolted to one of the deck-beams, and the other in the same manner strongly attached to a corresponding timber in the ship's side. Besides the great utility of knees in connecting the beams and timbers into one compact frame, they contribute greatly to the strength and solidity of the ship, in the different parts of her frame to which they are bolted, and thereby enable her with great firmness to resist the effects of a turbulent sea.

KNIGHT, in military concerns. This word is an anglicism of the German word *knecht*, signifying a person possessing the talents and bravery of a soldier, and rewarded for some particular acts of courage and address by the sovereign.

Knights, or Equites, in the Roman art of war, were originally instituted by Romulus, who selected three hundred athletic young men from the best families of the class of patricians, and had them trained to serve their country on horseback. This politic mode of securing the services of the most important part of the community to the existing government, was improved upon by Servius Tullus, after the introduction of the census, who admitted all persons worth four hundred sestertia into the noble order of the Equites, whose conduct and morals were irreproachable, a precaution highly honourable to the Roman character, and acted upon rigidly by monarchs, consuls, and censors. Having ascertained this point, by regular scrutiny, the name of the individual approved was enrolled with those of the order, a ring was presented to him as a pledge of his acceptance into it, and he received a horse provided at the public expense: thus instituted a knight, he was required and expected to appear at a moment's notice, ready to execute to the utmost of his ability those services which the state demanded.

There were three distinct and solemn acts performed by the government, calculated to impress the members with the necessity of adhering to their compact with their country; those were termed the Probatio, the Transvectio, and the Recensio. The first may be considered an annual examination as to the moral conduct of the Equites, the state of their arms, their horses, and their own health; the second, an universal assemblage of the knights in the forum, is thus described by Dyonisius: "The sacrifices being finished, all those who are allowed horses at the expense of the state, ride along in order, as if returning from a battle, being habited in the Togæ Palmatæ, or the Trabæ, and crowned with wreaths of olive. The procession begins at the temple of Mars, without the walls, and is carried on through all the eminent parts of the city, particularly the Forum, and the temple of Castor and Pollux. The number sometimes reaches to five thousand; every man bearing the gifts and ornaments received as a reward of his valour from the general. A most glorious sight, and worthy of the Roman grandeur." According to Plutarch, this honourable body of soldiers, and the rest of the army engaged in battle with the Latins, about the two hundred and fifty-seventh year of the city, were personally assisted by Castor and Pollux, who afterwards appeared in Rome mounted on horses foaming with exertion, near the fountain where their temple was subsequently erected; grateful for their supernatural aid, the Romans established the Transvectio in honour of the deified brothers.

The Recensio resembled the Probatio in some degree, except that more importance was attached to the former, as it was an universal muster of the whole people, including the Equites, to answer the useful military purposes of ascertaining the then state of discipline of men bearing arms, enrolling of new names, and expunging others. The ceremony occurred

every lustrum, under the superintendance of the censors.

When the Equites had accomplished the term for which their services were required, it was the established custom to lead their horses to the place where the two censors were seated in the Forum, to whom they related the circumstances attending their various campaigns, and under whom they served; they were then discharged either with honour or disgrace, as their conduct was approved or considered disgraceful.

It is generally admitted, that it is by no means correct to suppose that all the Roman soldiers mounted on horses were knights. Sigonius, and others, made a distinction in the cavalry between those who served *equo publico*, and those who served *equo privato*; "the former," says Kennet, "they allow to have been of the order of knights, the latter not. They demonstrate from the course of history, that from the beginning of the Roman state till the time of Marius, no other horse entered the legions but the true and proper knights, except in the midst of public confusion, when order and discipline were neglected."

Like all other institutions, this order began to degenerate, the life and soul of honour which supported it died and faded away, leaving a mere shadow of its pristine importance, indolence and avarice tempted individuals from the pursuit of military fame to the more innocent, and, perhaps, more laudable occupations of agriculture, and to partake of the emoluments to be derived from places of trust under the government; those who retained sufficient vigour of mind to consider themselves as still belonging to the order, obtained commands, and the mass of the cavalry was at length composed of foreign mercenaries. Fully sensible of the degraded state of the Equites, who wished to receive the honours due to them when deserving of honour, and a horse from their country, when that country no longer was remunerated by their services, subsequent princes deprived them of the horse, but suffered them to retain the golden ring.

Knights' *service*, this species of servitude was the consequence of the weakness and decay of the feodal system throughout Europe, and was invented as a remedy. Fiefs, which had previously been held for long terms of years, were made hereditary, and the holder was compelled to afford, without exception or a possibility of denial, as many soldiers to be maintained by the produce of the lands, as the lord proprietor was disposed to think proper; this became the tenure of knights' service; but a single soldier derived, as the service of a certain portion of land was termed, a knight's fee, and an estate furnishing a number of men trained for the field was said to contain an equal number of knights' fees; this system, extending in every direction, rendered each nation acting under it formidable and dangerous to the adjoining, as numerous armies might be assembled at a very short notice, and much blood spilt before reason had time to subdue sudden resentment, besides the means of oppression it afforded to men of large possessions. The armies thus assembled were commanded by the monarch, the nobles acted as officers, and all the varieties of vassals were considered and sorted as private soldiers. Exclusive of the tyranny of exacting personal service, the holders of knights' tenures were subject to all the ancient hardships of the old system, under the name of incidents, for chief aid, escheat, wardship and marriage, and they were compelled to bind themselves to their oppressor by oaths of homage and fealty.

It is supposed that knights' service had been universally established in Europe by the year 987; if so, there cannot be the least doubt that it was introduced into England by William of Normandy obtaining the absolute right of disposing of the territory of the conquered chiefs of this country; the obvious policy of the monarch was the distribution of it to those persons who had adopted his fortunes; and in what way could he more firmly bind them to his future support than by compelling them to furnish men by the prevailing tenure?

Pursuing this policy, the old tenants received fresh grants, and were thus secured by the subtle king from attempting to wrest his conquests from him; indeed it has been asserted, that the system was generally approved, as but few of the Anglo-Saxon fiefs were hereditary. The knights were bound to appear completely armed, with a lance, sword, shield and helmet, and well mounted, at the shortest notice from their superiors, and to remain in the field forty days at the expense of the chiefs of their fees. At length similar causes to those which have been mentioned to have actuated the Roman equites, induced the English knights to commute their personal services for fines, and hence arose the system of taxation.

An act of parliament was passed in the reign of Edward II. which required all persons possessed of 20*l.* per annum to

appear and receive the honour of knighthood from the king. This cause and others operated to produce such numbers of knights throughout Europe, that it became necessary to invent different orders of knighthood, to render some of the members at least of importance in the estimation of the community.

Charles I. strangely infatuated and mistaken in his conduct, adopted the obsolete practice of his ancient predecessors, and issued "a warrant to the sheriffs in 1626, to summons all persons that had for three years past held *40l.* per annum, or more, of lands or revenues in their own hands, or the hands of feoffees, and are not yet knights, to come before his majesty by the thirty-first of January, to receive the order of knighthood."

January 28, 1630, the king issued a commission to the Lord Keeper, Lord High Treasurer, &c. to compound with those who had made themselves liable to forfeiture, by neglecting to receive knightood according to act of parliament; alluding to the act of Edward II. This commission, absurd and oppressive beyond modern conception or endurance, produced above one hundred thousand pounds to the royal treasury, but did the king infinite injury in the opinion of his subjects, who had long considered the *statutum de Militibus* a nullity, and which was afterwards repealed by parliament. Charles, rather alarmed at the general expression of abhorrence excited by his conduct, published "a proclamation for the ease of his subjects, in making their compositions for not receiving the order of knighthood according to law, dated in the preceding July;" this however was nothing more than an attempt to soften the displeasure of the public, and failed of its effect. The ancient ceremony of making a knight consisted of giving the party a blow on the ear, and striking him on the shoulder with a naked sword, after which he had a sword girded round him, and spurs attached to his heels, and being otherwise completely armed as a knight, he was conducted in solemn procession to hear the offices of religion.

Since the above period knighthood has been considered a proper method of rewarding persons who have rendered slight services to the state, but the very frequent opportunities afforded of conferring the honour, has operated in producing the little estimation in which it is held, and from which there is no present prospect of its recovering. The observations just made must not at the same time be supposed to apply to the more honourable orders which have already been noticed under the article of Knights of the Bath, and Knights of the Garter, exclusive of the numerous foreign orders which have existed, and do still exist, in different parts of Europe.

Knights' *templars*. This order has been suppressed for many centuries, but as they were once considered a very powerful body, and had large possessions in England, of which the extensive and valuable domain, still known by the name of the Temple, in London, was a part, a slight sketch of their history appears to be necessary.

The order was instituted in the year 1118, for the actual defence of the places rendered sacred by the residence and acts of Jesus Christ, in the city of Jerusalem and its neighbourhood; and the house which they occupied, being purposely situated near the temple there, they acquired the name of Templars; and, from the same cause, their principal mansions throughout Europe were called temples. The Council of Troyes confirmed and established them in the rule of St. Bernard, in the year 1127, and the brethren were divided into two classes, knights, and servitors. Saladine having invaded and conquered the territories they had bound themselves to protect, they were compelled to leave the Holy Land, and to establish the order where they found a kind reception, which was almost in every part of the world then under the influence of the Christian religion, as they had double claims on the pious, proceeding from their peculiar profession and sufferings for the cause of the Saviour. During the period they depended upon the alms and bounty of the public, they were distinguished for their meek and meritorious conduct, which operated so greatly in their favour, that gifts flowed into their treasuries from the sovereign to the peasant, in every country where a house of knights' templars existed. Matthew Paris asserts, the order possessed 9,000 rich convents; and other writers add, that they had 16,000 lordships, with subordinate governors distributed in every part of Europe.

Under these prosperous circumstances, they became inflated by pride, and insolence usurped the place of meekness: relying upon their presumed consequence, they did not attempt to conciliate where they had offended; nor did they seem to suspect the hatred they had generated, till it was too late to resist or retract; such is the general tenor of the accounts given of the conduct of the knights temp-

lars by historians; but although those may be founded in fact, it is not to be supposed that pride alone caused the dissolution of the order: avarice, on the part of their oppressors, was the grand agent, and the riches of the knights the temptation to plunder them. Some of the members, resident in Paris, were indiscreet or wicked enough to cause a riot in the streets of that city. Philip the Fair, then on the throne of France, seizing on this opportunity, determined to make use of it to accomplish the total ruin of the order; he therefore procured the evidence of many infamous brethren, either by bribery or other means, who charged the knights generally with the most shocking enormities. Acting upon this base testimony, the king ordered the arrest of every templar in his dominions, abolished the order, and even caused fifty-seven of them to be burned to death: the Pope, influenced by the same spirit of injustice, and probably invited to partake of the plunder, called a general council at Vienna, by which the order was laid under an interdict.

Philip immediately communicated his proceedings to our monarch, Edward II. who returned an answer, dated October 30, 1307, in which he expressed great astonishment at the accounts received of the abominable heresy of the templars, and declared his intention of obtaining further information through the Seneschal of Agen. Clement directed a brief to Edward, dated the 30th of November following, explaining the conduct of Philip, and asserting, that the Grand Master had confessed, that the knights, at their admission into the order, denied the divinity of Jesus Christ, spit upon the crucifix, and worshipped an idol in their chapters; adding other charges, which appear equally wicked and incredible, but calculated to exculpate Philip, whose example the holy father recommended Edward to imitate in his own dominions. Edward seems to have acted, on this delicate occasion, with some degree of wisdom and resolution; but he was deficient in that firm spirit which governed Henry VIII. This is proved by a circular letter from him, directed to the Kings of Castile, Arragon, Portugal, and Sicily, dated December 4th, 1307; and another to the Pope, in each of which he expressed his disbelief of the accusations against the templars, and mentioned a priest who had endeavoured to confirm them to him, but ineffectually, as he was convinced the public agreed with himself in approving their manners and conduct; and yet, such is the weakness and instability of human nature, this very king was prevailed upon to issue an order, addressed to the sheriffs, for the apprehending of every templar in the kingdom, upon the feast of the Epiphany, 1308.

The Pope, fearful of the wavering disposition of the Monarch, sent another brief into England, repeating all the old charges, and producing others, which he addressed to the Archbishop of Canterbury, and his suffragans, at the same time informing them he had appointed three cardinals, four English bishops, and several of the French clergy, to manage the process to be instituted here against the unfortunate order. After the arrival of the commissioners alluded to, Edward had the good sense and precaution to command the invariable attendance of the British part of it on every day the business was prosecuted, by a letter directed to the Bishop of Lincoln, dated September 13th, 1309; thus shewing, that had he dared to save the templars, he would have done so without hesitation; but the king and the nation were equally alarmed at the consequences of anathemas and interdicts, and were compelled to acquiesce in the dictates of the commissioners, who sentenced the knights to eternal separation, and the loss of all their territories in Great Britain. To the everlasting honour of Edward, he rejected the cruel example of the King of France, and, instead of burning the knights, he merely confined them in different monasteries, where they resided, secure and comfortable, till their deaths. The estates of the Knights Templars having been confiscated, the king very naturally concluded that he was entitled to them, and consequently proceeded to sell and give them away; the Papal see, however, thought otherwise, and a fresh bull arrived, demanding them for the knights of the order of St. John of Jerusalem in England; as the same causes existed for compliance with this new mandate, which induced the suppression, the property in question was conveyed to the

Knights *of St. John of Jerusalem.* The order of St. John originated from the establishment of an hospital at Jerusalem, in the year 1048, by certain Italian merchants, for the reception of pilgrims and travellers, which they dedicated to the Baptist. The subsequent conquest of Jerusalem, by Godfrey of Boulogne, who wrested it from the Turks, was of infinite service to the hospital, which flourished in the same proportion with the facility thus afforded for visiting the holy city. Raymond, rector of the brethren

in its then state, being of an active and military turn, formed the plan of converting them into knights, captains, and servants; he marshalled them into bands, invented banners, and led them on against the Turks, as knights of the order of St. John of Jerusalem; they fought with great bravery; but the inferiority of their numbers occasioned frequent defeats, and they were at length compelled to give up their possessions to the conqueror Saladine: after a continued series of toils and misfortunes, and a constancy in the cause of religion which did them great honour, they were finally expelled from the Holy Land, in the year 1292.

The master and brethren fled to the island of Cyprus, where they employed their leisure in framing statutes for the government of the order; but recurring to their former military pursuits, they attacked Rhodes in 1308, which, with seven other islands, soon fell into their possession; they then assumed the addition of Rhodes to their previous titles; there they flourished for a very considerable length of time, and resisted the Turks with equal bravery and skill; but Sultan Soliman, having determined at all events to dislodge them, he assembled an army of 300,000 men, with which he invaded the island, and, after six months incessant fatigue and excessive loss, he succeeded in expelling them. The Emperor Charles V. gave them Malta at this critical æra, to which island the knights retired in 1523. There they underwent repeated invasions from the Turks, and obtained the admiration of all nations, for their invincible courage and address in repelling their attacks. The Knights of Malta, as they were now called, might have remained for centuries to come in quiet possession of their island, had they not been disturbed by a power they had little reason to dread till very lately: their surrender of it to the arms of France has been the means of placing it in the possession of England, and the order may be considered as almost extinct.

Jordan Brisset introduced the order into England, by founding the Priory of St. John, at Clerkenwell, where it flourished till the general dissolution of religious houses by Henry VIII. It will be sufficient to add, from Malcolm's "Londinium," "Camden says, that the priors were held equal in rank to the first barons of the realm; and their riches certainly enabled them to support their splendour of living. Such was their power and influence, that Edward III. thought it necessary, in the fortieth year of his reign, to appoint Richard de Everton visitor of the hospitals of this order in England and Ireland, to repress their insolence, and to enforce propriety of conduct; which appointment was repeated five years after by the same king."

Knight originally signified a servant; but there is now but one instance where it is taken in that sense, and that is knight of a shire, who properly serves in parliament for such a county; but in all other instances, it signifies one who bears arms; who for his virtue and martial prowess is by the king or one having his authority, exalted above the rank of gentleman to an higher step of dignity. They were called *milites*, because they formed a part of the royal army, by virtue of their feudal tenures; one condition of which was, that every one who held a knight's fee immediately under the crown, (which, in the reign of Edward II. amounted to 20*l.* per annum) was obliged to be knighted. He was also to attend the king in his wars, or fined for his non-compliance. The execution of this prerogative, as an expedient to raise money, in the reign of Charles I. gave great offence, though then warranted by law, and the recent example of Queen Elizabeth: it was, therefore, abolished by 16 Charles I. c. 20. Considerable fees accrued to the king on the performance of the ceremony. King Edward VI. and Queen Elizabeth had appointed commissioners to compound with the persons who had lands to the amount of 40*l.* a year, and who declined the honour and expence of knighthood.

Knights *banneret.* These knights are only made in the time of war. They are ranked next after the barons; and their precedence before the younger sons of viscounts was confirmed by James I. in the tenth year of his reign. But, to entitle them to this rank, they must be created by the king in person in the field, under the royal banners, in time of open war; otherwise they rank after baronets.

Knight *service*, a tenure where several lands were held of the King, which draws after it homage and service in war, escuage, ward, marriage, &c. but is taken away by statute 12 Charles II. c. 24.

KNOT, means the divisions of the log-line used at sea. These are usually seven fathoms, or forty-two feet; they ought to be fifty feet, and then as many knots as the log-line runs out in half a minute, so many miles does the ship sail in an hour,

supposing her to keep going at an equal rate.

Knots *of a rope*, among seamen, are distinguished into three kinds, *viz.* whole-knot, that made so with the lays of a rope that it cannot slip, serving for sheets, tacks, and stoppers: bow-link knot, that so firmly made and fastened to the cringles of the sails, that they must break or the sail split before it slips; and sheep-shank-knot, that made by shortening a rope without cutting it, which may be presently loosened, and the rope not the worse for it.

KNOWLEDGE, is defined, by Mr. Locke, to be the perception of the connection and agreement, or disagreement and repugnancy of our ideas.

KNOXIA, in botany, so called from Robert Knox, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: corolla one-petalled, funnel-form; seeds two, grooved; calyx one, leaflet larger. There is only one species, *viz.* K. zeylanica, a native of Ceylon.

KOELREUTERIA, in botany, so named in honour of Joseph Gottlieb Koelreuter, a genus of the Polygamia Monoecia class and order. Natural order of Trihilatæ. Sapindi, Jussieu. Essential character: calyx five-leaved; petals four; nectary double, four scalelets, and three glands; stamens eight, fixed to a column; germ three-sided, fixed to the same column; capsule three-celled, with two cells in each cell. There is but one species, *viz.* K. paullinoides; this is a tree, with an arboreous, upright, trunk, about six feet in height; branches scattered, spreading, when young having dotted glands scattered over them; buds from the axils of the leaves, resinous, cone-shaped with imbricate scales; peduncles, terminating, scattered, spreading, branched into many pedicles; flowers panicled, three or more on each pedicle. According to L'Heritier it is a polygamous tree, and a native of China.

KOENIGIA, in botany, so named in honour of John Gerard Koenig, M. D. of Courland, who first found this plant in Iceland. It is a genus of the Triandria Trigynia class and order. Natural order of Holoraceæ. Polygoneæ, Jussieu. Essential character: calyx three-leaved; corolla none; seed one, ovate, naked. There is but one species, *viz.* K. islandica.

KOS, in Jewish antiquity, a measure of capacity, containing about four cubic inches: this was the cup of blessing, out of which they drank when they gave thanks after solemn meals, like that of the passover.

KRAMERIA, in botany, so named in memory of John George, Henry, and William Henry Kramer, botanists, a genus of the Tetrandria Monogynia class and order. Essential character: calyx none; corolla four-petalled; nectary upper three-parted, lower two-leaved; berry dry, echinated, one-seeded. There is but one species, *viz.* K. ixina, this is a shrub with lanceolate leaves: flowers alternate, in terminating racemes. It was found in South America by Loefling.

KUHNIA, in botany, so called from Adam Kuhnius, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: flowers floscular; calyx imbricate, oblong, cylindrical; down plumose; receptacle naked; style deeply bifid; stigmas club-shaped; anthers distinct. There is but one species, *viz.* K. eupatorioides, a native of Pennsylvania.

KURTUS, in natural history, a genus of fishes of the order Jugularies. Generic character: body carinated above and below, and broad; back highly elevated; gill membrane, with two rays. This consists, as far as it is known, of only a single species. It inhabits the seas of India, and is supposed to live on insects, shell fish, and particularly young crabs. Its length is about ten inches, and its breadth four. Its colour, on the whole body, is that of silver foil, and its back is tinged with gold, and marked on its ridge with several black spots. For a representation of the kurtus, see Pisces, Plate V. fig. 1.

KYANITE, or Cyanite, in mineralogy, a species of the talc genus: its principal colour blue, though it occurs also white and grey; some specimens are entirely blue, others are only spotted, striped, or flamed with it. Externally and internally its lustre is shining and splendent, and completely pearly. It occurs in wedge-shaped concretions, which are often very promiscuous, and then pass into large and coarse grained distinct concretions. It feels greasy; is easily frangible, and the specific gravity is from 3.5 to 3.6. It is infusible before the blow-pipe, and is found to consist of

Silica	29. 2
Alumina	55. 0
Lime	2.25
Magnesia	2. 0
Oxide of iron	6.65
Water and loss	4. 9
	100.00

It is peculiar to the primitive mountains, where it occurs imbedded in talc slate, and mica slate, accompanied with grenatite. It is found in many parts of Europe. It is reckoned the link which connects talc with actynolite and trenolite.

KYLLINGIA, in botany, a genus of the Triandria Monogynia class and order. Natural order of Gramina. Cyperoideæ, Jussieu. Essential character: ament ovate or oblong, imbricate; flowers with a bivalve calyx and corolla. There are seven species, natives of the East and West Indies.

L.

L, Or l, the eleventh letter and eighth consonant of our alphabet. It is a semi-vowel, formed in the voice by intercepting the breath between the tip of the tongue and the fore-part of the palate, with the mouth open.

There is something of aspiration in its sound, and therefore the Welsh usually double it, or add an *h* to it; as in *llan*, or *lhan*, a temple.

In English words of one syllable, it is usually doubled at the end; as in *all*, *wall*, *mill*, &c. but in words of more syllables than one, it is only single at the end; as in *foretel*, *proportional*, &c. It may be placed after most of the consonants, as in *blue*, *clear*, *flame*, &c. but before none of them. As a numeral letter, L denotes 50; and with a dash over it, thus, $\overline{L}$, 50,000.

LA, in music, the syllable by which Guido denotes the last sound of each hexachord: if it begins in C, it answers to our A; if in G, to E; and if in F, to D.

LABDANUM, or LADANUM, is a resin obtained from the surface of the crystus creticus, a shrub which grows in Syria and the Grecian islands. It is collected while moist by drawing over it a kind of rake, with thongs fixed to it, from which it is afterwards scraped. When it is very good it is black, soft, and has a fragrant odour and a bitterish taste. Water dissolves about a twelfth part of it, and the matter taken up possesses gummy properties. When distilled with water, a small quantity of volatile oil arises. Alcohol may also be impregnated with a taste and odour of labdanum.

LABATIA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Guajacanæ, Jussieu. Essential character: calyx four-leaved, inferior; corolla subcampanulate, four-cleft, with two minute segments in the division of the corolla; capsule four celled; seeds solitary. There are two species, *viz.* L. sessiliflora, which is a native of Hispaniola; and L. guianensis is a tree exceeding forty feet in height, and three in diameter; the bark is of a russet colour; the wood is hard and white; the largest leaves are eight inches in length, and three in width; flowers axillary, or on the branches in pairs or threes; each on its pedicle; corolla greenish. It is called by the natives of Guiana, pourama pouteri.

LABEL, in heraldry, a fillet usually placed in the middle along the chief of the coat, without touching its extremities. Its breadth ought to be a ninth part of the chief. It is adorned with pendants; and when there are above three of these, the number must be specified in blazoning. This is a kind of addition to the arms of a second brother, to distinguish him from the first, and is esteemed the most honourable of all differences.

LABEL, in law, a narrow slip of parchment hanging from a deed, writ, or other writing, in order to hold the appending seal.

LABEL *of a circumferentor*, a long thin brass ruler, with a sight at one end, and

a centre hole at the other; chiefly used with a tangent line, to take altitudes.

LABIAL *letters*, those pronounced chiefly by means of the lips. See LETTER.

LABIATED *flowers*, monopetalous flowers, consisting of a narrow tube, with a wide mouth, divided into two or more lips. See BOTANY.

LABORATORY. A laboratory, properly fitted up with apparatus, is essentially necessary to a chemist whose objects lead him to make researches, experiments, and processes, upon all the different scales of operation. That great interest which the important science of chemistry has excited in all ranks of men, within the last thirty years, has rendered it easy to procure very complete sets of apparatus; which, at least in the metropolis, may be collected in a short time, by those who, like Boyle, Cavendish, Levoisier, and other great men, are in possession of ample means. But on the other hand, it is proper to remark, that many of our greatest discoverers, such as Scheele, Priestley, Berthollet, Wollaston, Dalton, Crawford, and a numerous set of eminent men, have from choice, or from motives of prudence, made use of very simple, cheap, and small sized apparatus. It is undoubtedly true, that many operations can only be performed upon a scale of considerable magnitude, and that many facts of great value display themselves upon the extensive theatre of nature or in large manufactories, which are either not seen, or require uncommon discernment to perceive them in the contracted space, and during the short time employed in the performance of a philosophical experiment. But it is no less true, that experiments upon a small scale do likewise possess their exclusive advantages. During the fusion and combination of substances, in the whole no larger than a pepper-corn, before the blow-pipe, the effects take place with rapidity, and many of them, such as the escape of gas by effervescence, the changes of colour, and transparency by differences in the heat applied, the manner of acquiring the solid state, &c. which cannot be seen in the furnace, are in the course of a few seconds remarked and ascertained. The saving of time is also an object of leading importance. The same considerations are likewise applicable to processes of fusion, or other applications of heat in a small vessel, such as a tobacco-pipe, placed in a common fire, urged by the bellows if necessary. Humid operations may also be very advantageously conducted by single drops of liquid, and small particles of solid bodies laid upon a glass plate, or in the metallic spoon, and the lamp for distillations, and other works even upon a scale of some magnitude, has long been a favourite instrument with chemists. These will come under our notice as we proceed.

Under our article CHEMISTRY we have given a concise sketch or enumeration of the practical treatment of bodies, which leads us to point out the instruments in this place.

For the mechanical division of bodies it is requisite the chemist should have the usual instruments for cutting, breaking, rasping, filing, or shaving. One or more mortars for pounding; the best are made of hard pottery. A stone and muller for levigating. A pair of rollers for laminating metals. A forge for many or most of the purposes in which the blast heat of a small fire is required; and various other tools and implements, not peculiar to chemistry.

Messrs. Aikin, in their Chemical Dictionary, give the following list of implements and materials; which, upon deliberate examination, we highly approve:

A gazometer, with the connecting tubes, blow-pipe, &c.

A bladder, or silk bag, with stop cock, fitting the above.

A pneumatic water trough.

A copper still with worm tub, the still fitting into the top of the Black's furnace.

A blow-pipe, with spoon, &c.

Lamps—an Argand, and others of common construction, for oil and alcohol.

An apparatus for drying precipitates by steam.

Scales and weights.

Large and small iron stands for retorts, &c.

Mortars—one of hard steel, one of bell-metal, and one or two of Wedgwood ware.

A silver crucible and spatula.

A platina crucible and spatula.

A jointed iron tube for conveying gases.

The following articles in glass:

Retorts of different sizes, plain and stoppered, and long necked for gases.

Receivers to fit the above, plain and stoppered, with or without an adopter.

Plain jars for gases, different sizes.

Lipped jars for mixtures, precipitates, &c.

A graduated eudiometer jar.

Bell receivers, two or three sizes.

Proof bottles.
Capsules, or small evaporating caps.
Water glasses (such as are used at table) which are very convenient for gentle evaporations.
Florence flasks.
Matrasses—two or three very small, and others of common size, round and flat bottomed.
Funnels—ribbed, and one plain, with a very long neck for charging retorts.
Wine glasses—common or lipped.
Watch glasses, for evaporating minute quantities at a very gentle heat.
Common decanters.
A bottle for specific gravity of fluids.
Phials of all sizes, plain and with ground stoppers.
Plain glass tubes of various thickness and bore, out of which may easily be made,
Syphon tubes,
Bent tubes for gases,
Capillary tubes, for dropping liquids, and various other useful articles.
A gas saturating apparatus.
A Woulfe's apparatus.
A tube of safety, separate.
A barometer.
Thermometers—common, and with the bulb naked, to dip into liquors.

The following in earthen ware:

Crucibles—Hessian, common and black-lead, of different sizes and shapes, with stands and covers.
Retorts.
Retort stands.
Cupels.
Wedgwood evaporating dishes—a set.
White basins, with lips, different sizes.
Common white cups and saucers.
Tubes—straight and bent.
Porcelain spoons.
Ditto rods, for stirring corrosive fluids.
Several stone-ware jars, with tin covers, for holding salts, &c.

Also the following sundries:

Wire—different sizes and kinds, *viz.* iron, copper, brass, silver, and platina.
Gold, silver, and brass leaf—tinfoil.
Wooden tripod stands for receivers, &c.
Fire tongs—various shapes.
Steel spatula and pallet knives.
Iron ladles.
Diamond for scratching glass.
Files—flat, three-cornered, and rat-tailed.
Hammers.

A vice and anvil.
Pincers.
Shears and scissars.
A magnet.
Sieves.
Filtering paper.
Corks.
Bladders—spirit varnish—sponge—tow—linen—flannel.
Windsor and common bricks—tiles—sand.
Lutes of various kinds.

For more extensive and delicate researches it is also necessary to have

A mercurial pneumatic trough.
A mercurial gazometer.
A burning lens of considerable power.
An electrical apparatus.
A Galvanic apparatus.
A detonating jar.
A glass or silver alembic.

The fuel to be employed has been already mentioned under that article, and a supply should be kept near at hand, broken down ready for use.

With regard to the different substances or re-agents to be kept, the chemist will, of course, wish to have a specimen of all the simple or individual substances, such as the acids, earths, metals, &c. but the simple and compound substances which are of general use, ought also to stand on the shelves.

For many purposes the ordinary degree of purity in which these substances are obtained by the common processes are sufficient; so, for example, the small quantity of potash in common sulphuric acid, and of iron in common muriatic acid, seldom interferes with any of the uses to which those re-agents are applied; but it is also necessary frequently to have them in the utmost purity when employed as tests for delicate purposes. The chemist will therefore find it of advantage to reserve a separate set of a few of the most necessary re-agents in their utmost purity, and if only employed when absolutely required, a very moderate quantity will suffice. In the subjoined list we have distinguished by the word pure those substances which require particular pains to be obtained absolutely pure. Mixtures of each of the stronger acids and water in two or three different and known proportions should also be kept.

N. B. The letter D implies, that the dry substance should be kept, and S, that it should be in solution.

Sulphuric acid, pure.
——— common.
Nitric acid, pure and boiled.
——— common and boiled.
——— fuming.
Muriatic acid, pure.
——— common.
Oxymuriatic acid. This should be kept in the dark.
Phosphoric acid, pure, from phosphorus. S.
Acetic acid.
Distilled vinegar.
——— constrated by frost.
Oxalic acid. S
Tartareous acid. S.
Sulphate of Potash. D. and S.
——— Soda. D. and S.
——— Barytes. D.
——— Alumina. S.
——— Strontian. D.
Alum. D and S.
Nitrate of Potash. D. and S.
——— Ammonia. D.
——— Barytes. S.
——— Strontian. S.
Muriate of Soda. D. and S.
——— Ammonia. D. and S.
——— Strontian. S.
——— Barytes. S.
——— Lime. D. and S.
——— Alumina. S.
Oxymuriate of Potash. D.
Phosphate of Soda. D. and S.
——— Ammonia. D.
Acetite of Barytes. S.
——— Alumina. S.
Oxalate of Ammonia. S.
Cream of Tartar. D.
Crude Tartar. D.
Tincture of Galls.
Borax. D. and S.
——— vitrified.
Fluate of Ammonia. S.
Succinate of Ammonia. S.
Prussiate of Potash, pure and dry. This should be kept in the dark.
Prussiate of Lime. S.
Plaster of Paris.
White marble.
Bone-ash.
Fluor Spar.
Potash, pure. S.
——— common caustic. S.
Pearl-ash. D. and S.
Salt of Tartar. D. and S.
Super-carbonate of Potash. D.
Carbonate of Soda. D. and S.
——— fully dried.
Ammonia, pure.
Carbonate of Ammonia. D. and S.
Super-carbonate of ditto. D.
Lime.
Lime-water.
Barytic-water.
Strontian-water.
Carbonate of Magnesia.
Hydro-sulphuretted water.
Hydro-sulphuret of Soda. S.
——— Ammonia. S.
Sulphuret of Potash. D.
White Arsenic. D. and S.
Manganese, black oxide of.
Mercury.
——— red oxide of.
Nitrate of Mercury. S.
Corrosive muriate of ditto. D. and S.
Zinc, in sticks and granulated.
Tin.
Muriate of Tin.
Lead.
Minium and Litharge.
Nitrate of Lead. S.
Acetite of ditto. S.
Iron, filings, turnings, wire.
Sulphuret of Iron for sulphuretted hydrogen gas.
Sulphate of Iron. D. and S.
——— saturated with nitrous gas.
Muriate of Iron.
Copper, sheet, wire.
Nitrate of Copper. D. and S.
Silver, leaf and wire.
Nitrate of Silver. S.
Sulphate of ditto. S.
Acetite of ditto. S.
Gold-leaf.
Nitro-muriate of Gold.
——— Platina.
Sulphur.
Phosphorus.
Alcohol, concentrated and common.
Sulphuric ether.
Litmus Tincture.
Turmeric.
Brazil wood.
Gall-nut.
Catechu.
Isinglass.
Olive-oil.
Linseed-oil, drying.
Oil of Turpentine.
Black flux.
Distilled water, in great plenty.

The most convenient arrangement for a laboratory, where space is not wanted, seems to be that of two rooms, and a shed or apartment which can be thrown open to communicate with the air. The first may contain the books of register, of practical reference, together with the more delicate philosophical and chemical instruments, products, and preparations.

The second may be provided with the work-bench, hammers, anvil, vice, and other tools, and the different furnaces; and the shed may be devoted to experiments of danger, such as arise from explosions, noxious vapours, and the breaking of vessels. It will be most convenient that these should be upon the ground floor, to secure the advantage of a ready supply of water or fuel, and other articles of heavy consumption. The first of which articles may be largely wanted, in case of accidental combustion, as well as on common occasions. But it is likewise necessary that the place should be dry, in order that labels may be preserved, and other inconveniences avoided. This is the principal general argument in favour of a laboratory above the ground floor.

It would carry us too far beyond the limits of our work, if we were to give drawings and descriptions of the great variety of vessels, furnaces, and apparatus, which have been contrived for general and particular purposes of chemistry; and many of the culinary and domestic vessels may also be applied in experimental chemistry. We shall therefore confine ourselves to a few of the most simple and useful.

In Plate Laboratory, fig. 1, represents a retort, *a*, and receiver, *b*. These vessels are used for distillation. The subject is put into the belly of the retort, *a*, and exposed to heat, and the volatile products pass over into the receiver, *b*, which may be kept cool by the application of wet cloths, or by immersion in cold water, or otherwise, if needful. The place of junction is secured either by fitting the necks together, by grinding, or by means of a lute, which see farther on. At *c*, in the receiver, is a neck closed by a stopper. Receivers or retorts, with this additional neck, are said to be tubulated. Fig. 2, is an alembic, of which *a* is the body, *b* the head, and *c* the neck. Generally speaking, this is not a very useful instrument. In large distillations an alembic or still is used, but the condensation is effected by a spiral pipe, called the worm, which passes through a tub of cold water; in the use of the alembic, fig. 2, the beak is inserted into a receiver. When the volatile product of a body exposed to be dried, or to undergo evaporation by heat, is not required to be preserved, the process is performed in an open vessel.

The application of heat to vessels is made either by naked fire, or by the intervention of some heated substance, which is then called a bath. Chemical baths are made of sand, or of melted lead, or the fusible metal, or of brine, and very frequently of water. The evaporable liquids form a bath which cannot be heated beyond their respective boiling points; and the other baths, the most common of which is that of sand, are chiefly valuable for giving a regular heat without sudden changes.

This last purpose is effected likewise with glass vessels, by coating them with a lute.

A very great number of furnaces have been constructed for chemical and manufacturing puposes, for which we must necessarily refer to the extensive works appropriated to these objects. The operative chemist may have occasion for them of different sizes and figures. A great deal may be done with the common German stove, and with small furnaces made out of black-lead pots. But, in general, the philosophical chemist will be well accommodated with one good furnace, convertible to different uses; and out of many such we select that of Dr. Black, for its simplicity and efficacy, as described in his lectures.

Plate-iron is by far the best material for the outside of an experimental furnace, but, as its metal communicates heat very fast, this must be cut off by a proper lute lining. The Doctor so far succeeded in this respect, that his furnace though only two inches thick in the middle, will not scorch paper applied to its outside, when it is melting iron within. He adopted the simplest rectilineal shapes, because workmen find great difficulty in executing curved and uncommon forms; and not one of a score of them will do it with accuracy. Indeed, those highly praised forms seemed to him of very little importance in most cases.

The body, or fire-place, is the only part of this furnace that requires description; the ash-pit, with its door and registers and grate, being constructed as in any other furnace. It will be easily understood by considering the section represented in fig. 3.

The base, represented by the dotted line A B C, and the top, K L M, are oval plates of iron, the longer diameter, A C, being to the shorter as three to two nearly. The base and top are equal, so that the sides, K A, M C, are upright, the whole body forming an oval cylinder. D E F, is half of the hole in the bottom, which is occupied by the grate fixed on

the top of the ash-pit. G H I is half of the mouth of the furnace, which receives a still, or a sand-pot, for distillation, with a retort. This is a little nearer to the front, K, of the top, than the grate-hole is to the front, A, of the bottom, so that the luting is thicker below than above. Near the back, M, of the furnace is a smaller hole P, for the vent. The luting at Q and R is so formed that the cavity of the furnace does not greatly differ from a cylinder, except in so far as the vent, PO, does not communicate with it abruptly, but is gradually curved downwards, as represented in the figure, making the middle of the cavity more roomy backwards, by which means it contains a greater quantity of fuel. S is the section of the luting, which forms a sort of an arch, or bridge, contracting the entry of the vent. An iron pipe is set on at P to increase the draught of the chimney. The fuel is put into the furnace by the aperture P, and the sloping form of the cavity causes it to distribute itself pretty uniformly.

When the furnace is used for smelting, the crucible is set on a pedestal standing on the grate, and the fuel is placed round it with great ease, the mouth of the furnace being open. This is then shut up by a stopper made on purpose, or by a flat fire-tile simply laid on it.

When we would distil with a naked fire, the retort has its bulb resting on a ring which hangs on the mouth of the furnace by three hooks, and the neck of the retort lies over the front of the furnace. The space round the retort, at the mouth of the furnace, is closed, as much as is necessary, by two or three pieces of tile, shaped so as nearly to fit the bulb of the retort when they are laid on the mouth of the furnace. A quantity of light ashes are now to be laid on these tiles, and heaped up so as to cover the bulb and part of the neck of the retort. Dr. Black found that this produced a very gradual diminution of the heat, as it recedes from the fuel, and is less liable to crack the retort, by inequality of heat, than any other contrivance. Scarcely any process occurs which this furnace does not answer with great ease.

In using the furnaces most convenient for experimental chemistry, (namely, those made of plate iron) it is necessary that the iron be defended from the heat by lining or lute, as we call it, on the inside; and such lutes are necessary in other occasions in chemistry; as when we have occasion to close the joining of the vessels with one another, or to give a coating to retorts, or even to crucibles, which is sometimes done. The materials employed for these purposes have their general denomination from clay, of which some of the most useful are partly composed, though there are some that do not contain any of it. They may be divided into such as contain animal or vegetable matter, of the glutinous or adhesive kind, and such as are composed only of earthy substances. The first are used for closing the joining of vessels, when the heat we mean to apply is not to be strong, nor the vapours to be produced corrosive. The second serve for the lining of furnaces, or for closing the joinings of vessels, in operations in which the vapours are very corrosive, or in which a strong heat must be employed, which would scorch, or burn and destroy, any animal or vegetable glutinous matter.

The joinings of vessels with one another, which we have the most frequent occasion to close up by means of lutes, are those of retorts with receivers. And we may remark, in the first place, with regard to these, that there are not many operations in which it is necessary to make the joining perfectly close, except when the receiver is provided with an air-pipe. On the contrary, it is dangerous, on account of the air which must be allowed to escape in some manner. Therefore we are not anxious to contrive the most close and compact. They are sufficient and better if they be moderately so, and in some cases, when we think the lute too close, we even obviate it by a pinhole. The animal and vegetable lutes, employed in this way, are glue and chalk mixed in thin paste, and spread on slips of paper; or gum arabic and chalk, used in the same manner; or flour and water; or a bladder; or linseed meal; or fat lute. M. Lavoisier recommends, for joinings which we desire to be air-tight, but which are not to be exposed to heat, the following: to sixteen ounces of bees-wax add one and a half or two of turpentine, and keep it for use. When used, soften and make it tough, by warming and working between the fingers; then put it on the joint in little rolls, and make it close; and, lastly, cover it with slips of wet bladder laced with pack-thread. But, if the joint is liable to be warmed, or heated, during the operation, you must take fat lute. This is made of raw pipe-clay and linseed oil, beaten together very hard, to the consistence of a stiff adhesive paste.

Of the second kind of lutes, called the fire-lutes, a great variety have been proposed, and some of them compositions of

many ingredients, but none are equal, or superior, to clay and sand; *viz.* sand 3, or 4, or 5, or 6, to clay 1. These are for luting vessels together, and for coatings. But in lining furnaces, Dr. Black used a double lining; first, a charcoal-lute; secondly, a fire-lute.

He found that a layer of powdered charcoal, beaten up, or kneaded, with as little water as will give its particles adhesion enough to attach itself to the metal sides of the furnace, by means of cautious beating, forms a firm stratum, which is the most imperfect conductor of heat of all that he had tried. When this layer of charcoal is defended from the action of the air by a layer of fire-lute, composed of one part of fine clay, and three or four parts of sand, carefully put on, and consolidated by gently beating it from day to day, till it no longer receives an impression from the mallet, it will last as long as any part of the furnace. Its durability will be greatly improved, without much change in its conducting power, by using, instead of pure water, water made muddy by about one-twentieth of pipe-clay. If finely powdered charcoal be kneaded with one-fifth of pipe-clay, it may be kneaded and formed into any shape, and will be so impervious to heat, that a bit of it may be held in the fingers within an inch of where it is red hot. Such a composition is, therefore, very proper for the doors of furnaces, and for stopples for such apertures as must be frequently opened and shut.

Fig. 4, represents an Argand's lamp capable of being adjusted at different heights, by a sliding socket, on a stem or rod. Another similar socket is seen above, into which a ring of wire is inserted for supporting the retort, *a*, at any required distance above the flame. A third socket may be added, still higher upon the stem, for supporting another wire, which will afford the means of steadying an alembic, or any other apparatus, by a string or small flexible wire answering the same purpose. This is a very convenient method of disposing vessels for the lamp heat, upon a small or moderate scale, for distillations, sublimation, evaporation, drying, and the like. A small sand-bath may be placed, when needful, in the wire above the flame: *b* is an intermediate condensing vessel, called a quilled receiver, which conveys the condensed product into a bottle, *c*. The rod which supports *b* shows how useful these instruments are in their various applications.

The condensation of vapours after distillation, and the transmission of gases, which may arise along with them to their receptacles, has been very well and scientifically effected by the late Mr. Woulfe, in an apparatus of bottles which is distinguished by his name. The original contrivance will be easily understood by description, and instead of a drawing of that arrangement of vessels, we shall give one of the most simple, safe, and convenient, of all the improvements which have since been made in it; namely, that contrived by Dr. Hamilton, and figured at the end of his "Translation of Berthollet on Dyeing." Suppose the retort and receiver, (fig. 1.) or any other distillatory apparatus, to have a communication from the upper parts of the receiver, *a*, at *c*, by a tube leading into a bottle having three necks, and partly filled with water, beneath the surface of which the said tube, after passing this, an air-tight cork was plunged. Another of the necks of the bottle is provided with an upright open tube, also passing a cork, and plunged in the water, in order that air may enter in case of absorption, or the liquid may rise a little in it, in case of pressure from within. The third neck of the bottle affords a communication by means of a tube with another two necked bottle, fitted up in all respects in the same manner as the bottle communicating with *e*. And in this manner we may conceive a series of three or more bottles, the last of which may communicate with a pneumatic apparatus which is to receive the incondensable gas. This system of bottles and tubes is sometimes fitted together by grinding, and sometimes made secure by lutes; but in most constructions, though the advantages are very considerable, the apparatus is difficult to be put together, and easily deranged or injured.

Fig. 5, represents Dr. Hamilton's apparatus. A is the retort fitted by grinding into a plug or piece, B, represented at *b*, which last is also fitted by grinding into the neck of a globular receiver, C.

The use of the additional piece, *b*, is to afford a due inclination to the retort by an obliquity of its perforation or hole, instead of allowing it to remain horizontal, as it would, if fitted to the hole in C, and also to facilitate the grinding in of a new retort, in the case of breakage. The piece, *b*, has a stopper, *a*, which can be put whenever the retort is taken out, whether for weighing at, or for any other purpose. The first receiver, C, has a smaller neck opposite to B, which is ground into a corresponding neck of D, the second receiver, which last is tubulated, and has a tube, H, open at both ends, ground into its ver-

tical neck, for the purpose of permitting absorption, and re-acting, by its contents, against the force required to protrude any gas through the bended tube I K L. Every one of the range of the receiver, E F G, has also two necks, by which they are successively fitted to each other, and each interior neck has a tube of about a quarter of an inch fitted into it, which, by its curvate, reaches nearly to the bottom of the liquid (usually water) placed in each. By this disposition, the usual first product of condensation is received in C, and the purer vapours, proceeding to D, are in part condensed by the water placed therein, and are partly urged through the tube I, into contact with the water in E: and whatever may escape condensation in E, will be urged through the tube, K, into the liquid in F; and in this manner the operation may proceed through the whole set of vessels, till the gasiform remaining product, if any, shall pass out then beneath the mouth of one or the other of the three inverted bottles at P, which are filled with water, and have their mouths immersed below the surface of the water, in a dish at the end of the series. S and *s* are a pair of pieces of wood which serve to support one of the globes, and very conveniently afford an adjustment, by pressing them more or less near together. This apparatus is drawn upon a scale of about half an inch to a foot, which is a proper size to be worked by an Argand's lamp; if it were made larger, the retort would of course require to be supported, as usual, by the parts of the furnace, or otherwise.

The dish and bottles at the extremity of this apparatus show how the gases or permanently elastic fluids are received and managed. For such gases as are not absorbed by water, a wooden tub may be used, having a shelf therein, at such a depth as to stand a little below the intended surface of the water; or, instead of a shelf, a short-legged stool, loaded with lead, may be used, and in that case any tub or vessel may be used. Jars, or vessels of any convenient figure, being filled with water by immersion, and turning them bottom upwards, may be placed on the shelf, which should have holes in it for the convenience of pouring up any gas, whether from another jar, bottle or vessel, or from the neck or tube of a retort, or other apparatus. Jars, &c. thus filled may be conveyed away, either by corking the bottle, or by putting a saucer, or other shallow vessel, beneath the mouth of the jar, and taking both out together, with water in the saucer.

Gases which are absorbed by water are usually received over mercury, in which case, on account of the weight, as well as the expence of the fluid, the vessels are made smaller, and the trough has a deep cavity sufficient for immersion, but no larger, and a broad shallow part of the trough supplies the place of a shelf for the jars to stand upon; and there is an actual shelf at one part only over the end of the deep cavity. Fig. 6, represents a trough for mercury, which may be made of wood or of stone. The space, V, admits the jar, A, to be immersed, and when full it is raised and placed bottom downwards upon the shallow bottom. G is a retort, containing some materials, from which gas, being extricated, rises beneath A, and displaces the mercury. X and Y are grooves, into which one or more wooden shelves may be slided, as occasion may require, in which application they are first introduced at the wider part, T, in the plan, fig. 7.

An apparatus, almost indispensable in experiments on the gases, is a gazometer, which enables the operator to receive and preserve large quantities of gas with the aid of only a few pounds of water. These vessels are made of various forms, but one of the most simple is shown in fig. 8. It consists of an outer fixed vessel, *d*, and an inner moveable one, *c*, both of japanned iron. The latter slides easily up and down within the other, and is suspended by cords passing pullies, to which are attached the counterpoises, &c To avoid the incumbrance of a great weight of water, the outer vessel, *d*, is made double, or is composed of two cylinders, the inner of which is closed at the top and at the bottom. The space only of about half an inch is left between the two cylinders, as shown by the dotted lines. In this space the vessel, *c*, may move freely up and down. The interval is filled with water as high as the top of the inner cylinder. The cup or rim on the top of the outer vessel, is to prevent the water from overflowing when the vessel, *c*, is forcibly pressed down, in which situation it is placed whenever gas is about to be collected. The gas enters from the vessel in which it is produced, by the communicating opening, *b*, and passes along the perpendicular pipe, marked by dotted lines in the centre, into the cavity of the vessel, *c*, which continues rising till it is full.

To transfer the gas, or to apply it to any purpose, the cock, *b*, is to be shut,

and an empty bladder, or bottle of elastic gum, furnished with a stop cock, is to be screwed on *a*. When the vessel, *c*, is pressed down by the hand, the gas passes down the central pipe, which it had before ascended, and its escape at *b* being prevented, it finds its way up a pipe which is fixed on the outer surface of the vessel, and which is terminated by the cock, *a*. By means of an ivory mouth-piece screwed on this cock, the gas included in the instrument may be respired; the nostrils being closed by the fingers. When it is required to transfer the gas into glass jars standing in water, a crooked tube may be employed, one end of which is screwed upon the cock, *b*, while the other aperture is brought under the inverted funnel, fixed into the shelf of the pneumatic trough.

Several alterations have been made in the form of this apparatus, but they are principally such as add merely to its neatness and beauty, and not to its utility; and they render it less easy of explanation. The counterpoises, *e e*, are now generally concealed in the framing, and the vessel *c* is frequently made of glass.

When large quantities of gas are required (as at a public lecture) the gas holder, fig. 9, will be found extremely useful. It is made of tinned iron plate, japanned both within and without. Two short pipes, *a* and *c*, terminated by cocks, proceed from its sides, and another, *b*, passes through the middle of the top or cover, to which it is soldered, and reaches within half an inch of the bottom.

It will be found convenient also to have an air cock with a very wide bore fixed to the funnel at *b*. When gas is to be transferred into this vessel from the gazometer, the vessel is first completely filled with water through the funnel, the cock *a* being left open and *c* shut. By means of an horizontal pipe, the aperture *a* is connected with *a* of the gazometer. The cock *b* being shut, *a* and *c* are opened, and the vessel *c* of the gazometer, fig. 8, gently pressed downwards with the hand. The gas then descends from the gazometer till the air-holder is full, which may be known by the water ceasing to escape through the cock *c*. All the cocks are then to be shut, and the vessels disunited. To apply this gas to any purpose, an empty bladder may be screwed on *a*; and water being poured through the funnel *b*, a corresponding quantity of gas is forced into the bladder. By lengthening the pipe, *b*, the pressure of a column of water may be added; and the gas being forced through *a*, with considerable velocity, may be applied to the purpose of a blow-pipe, &c. &c.

The gazometer, already described, is fitted only for the reception of gases that are confinable by water, because quicksilver would act on the tinning and solder of the vessel, and would not only be spoiled itself, but would destroy the apparatus. Yet an instrument of this kind, in which mercury can be employed, is peculiarly desirable, on account of the great weight of that fluid; and two varieties of the mercurial gazometer have therefore been invented. The one of glass is the contrivance of Mr. Clayfield, and may be seen represented in the plate prefixed to Mr. Davy's researches. In the other, invented by Mr. Pepys, the cistern for the mercury is of cast iron. The drawing and representation of it may be found in the fifth volume of the Philosophical Magazine; but as neither of these instruments are essential to the chemical student, and as they are required only in experiments of research, we refer to the minute descriptions of their respective inventors.

Very complete sketches of chemical instruments and furnaces may be seen in Henry's chemistry.

After the general description we have here given of the arrangement and apparatus for chemical experiments, we shall conclude with a short account of the blow-pipe.

It is a tube which terminates in a perforation not exceeding the hole which might be made by a small pin. There is no difficulty, in case of emergency, in making one out of a tube of glass, and the common blow-pipes sold at the ironmongers for a few pence, and in universal use with workmen, are very good. Others more costly and elegant, which have a small space for the condensation of the vapour of the breath, are sold by the makers of chemical apparatus. It requires some address to produce a constant stream of air by blowing through this pipe; but the principal artifice consists in keeping the tongue to the roof of the mouth, and using the breath by the pressure of the muscles of the face instead of the chest. Some workmen in glass contrive to hold the pipe steady between the teeth, and by that means have both hands at liberty for use; but as this requires uncommon steadiness in the head, the philosophical chemist will probably prefer fixing his pipe to one of his stands. Some blow-pipes have been made, through which a a stream of vapour from boiling alcohol is

urged; but these instruments seem to be rather toys than of use to the actual chemical investigator. It appears preferable to use bellows, as the enamellers do, where an extensive application of this implement is required; though in this case the desirable requisite of portability is lost sight of.

The bodies intended to be heated by the blow-pipe must not, in general, exceed the size of a pepper-corn, unless bellows and a very large flame be used. The proper supports are, either a piece of smooth, close-grained charcoal, for such bodies as are not subject to an alteration of their properties, from the inflammability of the coal, as might be contrary to the nature of the investigation. This support is therefore most frequently used; as it is properly adapted for saline, earthy, and many metallic bodies. The other support consists of a spoon, somewhat less than a quarter of an inch in diameter, made of a metal not subject to oxydation; that is to say, pure gold, silver, or platina, or such a mixture of these metals as might be found to be least deficient in the requisite degree of hardness, which gold or silver alone does not possess. Bergman advised to add one-tenth of platina to a given mass of silver. There is, however, no very considerable inconvenience resulting from the use of a small spoon, either of gold or of silver; and platina possesses every quality which can be wished for. The small metallic spoon must of course be properly fixed in a socket of metal, provided with a wooden handle.

Very small or pulverulent substances are apt to be carried away by the current of flame. These may be secured by making a small hole in the charcoal, into which the powder is to be put, and covered with another small piece of charcoal, which partly protects them from the flame. Some experiments of reduction are made by binding two small pieces of charcoal together, cutting a channel along the piece intended to be the undermost, and making a cavity in the middle of this channel to contain the subject matter of examination. With this apparatus the flame is urged through the channel between the two pieces of coal, and violently heats the substance in the cavity, which may be considered as a closed vessel.

A great number of mineral bodies are not fusible by mere flame, urged by common air through the blow-pipe; though oxygen gas subdues most bodies. See Gas *oxygen.*

Whenever, therefore, the fusion of any refractory substance is to be attempted, some other substance must be added which is more fusible, and capable of dissolving the former. These solvents in the dry way, are distinguished by the name of fluxes, and, like the solvents used in the humid way, are mostly saline. It may easily be imagined, that the nature of the products will greatly vary, according to that of the flux, which enters into combination with them; and accordingly they are varied in experiments, as well as in operations, in the large way. The blow-pipe experiments, though conducted upon the same principles as those upon a larger scale, differ nevertheless from them in two particulars; namely, that the whole of the phenomena are visible throughout, and that the residues are of no value, otherwise than as they serve to indicate facts. For these reasons, every flux, without exception, might be used with the blow-pipe, provided it were not of such a nature as to sink into the charcoal. We may therefore select a certain small number of the most convenient fluxes, and note the effects which they respectively produce upon the various mineral bodies; and these will serve as indications to enable the chemical enquirer to distinguish them again with a great degree of accuracy, not to mention, that he may also derive much advantage, with regard to the more extensive operations he might be disposed to undertake. A considerable part of this preliminary labour has already been performed by Engestrom, Bergman, Mongez, and others; and it is now become usual for chemists, among their other experiments on minerals, to mention their habitudes with the blow-pipe.

The fluxes which have obtained the general sanction of chemists, on account of the extensive use they have been applied to by Bergman, are phosphoric acid in the dry or glassy state, soda, and borax, or the native borate of soda.

LABOUR, in general, denotes a close application to work or business. Among seamen a ship is said to be in labour when she rolls and tumbles very much, either a hull under sail, or at anchor. It is also spoke of a woman in travail, or child-birth. See Midwifery.

LABRADOR *stone*, in mineralogy, is of a grey colour, passing into a dark ash.

It exhibits, however, under certain circumstances, a great variety of colours, as blue, green, yellow, red, and brown, in their different shades. It shows, likewise, spotted and striped delineations. Sometimes the same spot if held in different directions changes its colour from blue to green, &c. The beautiful colours seldom extend over a whole piece; in general, they show themselves only in large and smaller spots and patches. Different colours are presented, according as the piece is held between the light and the eye, or the eye and the light. It occurs massive, in blunt edged and rolled pieces. Its principal fracture is shining, passing into splendent. Specific gravity is about 2.7. It runs into a white enamel, with addition before the blow-pipe. The constituent parts are

Silica	69.5
Alumina	13 6
Sulphate of lime	12.0
Oxide of copper	0.7
Oxide of iron	0.3
	96.1

It makes a part of certain kinds of green stone, and is accompanied with mica and shorl, though seldom with iron pyrites. It was originally discovered by the Moravians, in the island of St. Paul, on the coast of Labrador, where it is still to be met with in plenty, also in some parts of Denmark and Norway, and near the romantic Lake of Baikel in Siberia. It is used for many ornamental purposes.

LABRUS, in natural history, a genus of fishes of the order Thoracici. Generic character: teeth strong and sharp; the grinders sometimes convex and crowded; lips thick and doubled; rays of the dorsal fin in several species prolonged into soft processes; gill-covers unarmed and scaly: There are ninety-eight species enumerated by Shaw, of which we shall notice merely the following: L. scarus, is about the length of twelve inches, and is found in the Mediterranean in immense shoals. It was well known to the ancients, and highly admired by them, being considered as one of the most luxurious dainties. For a representation of the blue-finned Labrus, see Plate V. fig. 2.

LABYRINTH, in anatomy, the internal cavity of the ear, so called from sinuosities and windings. See Ear.

Labyrinth, in gardening, a winding mazy walk between hedges, through a wood or wilderness. The chief aim is to make the walks so perplexed and intricate that a person may lose himself in them, and meet with as great a number of disappointments as possible. They are rarely to be met with, except in great and noble gardens, as Versailles, Hampton court, &c. There are two ways of making them; the first is with single hedges: this method has been practised in England; and these may, indeed, be best, where there is but a small spot of ground allowed for making them; but where there is ground enough the double is most eligible. Those made with double hedges, with a considerable thickness of wood between them, are approved as much better than single ones: this is the manner of making them in France and other places; of all which that of Versailles is allowed to be the noblest of its kind in the world. It is an error to make them too narrow; for that makes it necessary to keep the hedges close clipped: but if, according to the foreign practice, they are made wide, they will not stand in need of it. The walks are made with gravel usually set with horn-beam: the pallisades ought to be ten, twelve, or fourteen feet high; the horn-beam should be kept cut, and the walks rolled.

LAC, *gum*, in chemistry, is a very singular compound, prepared by the female of a very minute insect, the coccus lacca, found on some trees in the East Indies, particularly the banyan fig. The insect is nourished by the tree, fixing itself upon the twigs and extremities of the succulent branches, where it deposits its eggs, which it glues to the branch by a red liquid, the outside of which hardens by the air, and serves as a cell for the parent insect. This increases in size, and the young insects at first feed upon the enclosed liquid, and after this is expended, they eat through the coat, leaving a hollow red resinous bag, which is "stick-lac." The best lac is procured from the province of Acham, but it is obtained in great plenty on the uncultivated mountains on each side of the Ganges. There are four kinds of lac, *viz.* "stick-lac," which is lac in its natural state, without any preparation; "seed-lac," which is stick-lac broken into small lumps, and granulated; "lump-lac," which is seed-lac liquified by fire; "shell-lac," which is a preparation of the stick-lac. By a number of very ac-

curate experiments made by Mr Hatchett, it is found that lac consists of a colouring extract of resin, gluten, and wax; all of them in intimate combinations: the proportions of the stick-lac are as follow:

Resin	68.0
Wax	6.0
Gluten	6.5
Colouring extract	10.0
Extraneous substances	6.5
	96.0

Lac is employed for a variety of purposes in the arts: the finer specimens are cut into beads for necklaces. It enters largely into the composition of sealing-wax, and hard japans or varnishes: and it is much used in dying.

Lac *sulphuris*, in medicine, a sulphur separated by acid from its alkaline solution. In this state it is thought to be milder and a more efficacious medicine than in its crude state, and is certainly less nauseous to the taste. See Sulphur.

LACCIC *acid*, in chemistry, a white or yellowish production of insects, called white-lac. Some of this substance, brought from Madras, was analyzed by Dr. Pearson, who found that it bore a considerable analogy to bees-wax. A full account of Dr. Pearson's experiments may be seen in the eighty-fourth volume of Philos. Trans. The component parts of this acid are supposed to be carbon, hydrogen, and oxygen.

LACE, in commerce, a work composed of many threads of gold, silver, or silk, interwoven the one with the other, and worked upon a pillow with spindles, according to the pattern designed. The open-work being formed with pins, which are placed and displaced as the spindles are moved.

Lace, *bone*, a lace made of fine linen, thread, or silk, much in the same manner as that of gold and silver. The pattern of the lace is fixed upon a large round pillow, and pins being stuck into the holes or openings in the pattern, the threads are interwoven by means of a number of bobbins made of bone or ivory, each of which contains a small quantity of fine thread, in such a manner as to make the lace exactly resemble the pattern. There are several towns in England, and particularly in Buckinghamshire, that carry on this manufacture; but vast quantities of the finest laces have been imported from Flanders.

LACERTA, the *lizard*, in natural history, a genus of Amphibia, of the order Reptiles. Generic character: body four-footed, tailed, naked and long, having no secondary integument; legs equal. There are, according to Gmelin, eighty-one species, of which the following are principally deserving of attention. L. crocodilus or the crocodile, is a native both of Africa and Asia, but is most frequently found in the former, inhabiting its vast rivers, and particularly the Niger and the Nile. It has occasionally been seen of the length of even thirty feet, and instances of its attaining that of twenty are by no means uncommon. It principally subsists on fish, but such is its voracity, that it seizes almost every thing within its reach. The upper part of its body is covered with a species of armour, so thick and firm, as to be scarcely penetrable by a musket ball, and the whole body exhibits the appearance of an elaborate covering of carved work. It is an oviparous animal, and its eggs scarcely exceed in size those of a goose. These eggs are regarded as luxuries by the natives of some countries of Africa, who will also with great relish partake of the flesh of the crocodile itself. When young, the small size and weak state of the crocodile prevent its being injurious to any animal of considerable bulk or strength, as those which have been taken living to England have by no means indicated that ferocious and devouring character which they have been generally described to possess, a circumstance, probably, owing to the change of climate, and the reducing effect of confinement. In its native climate its power and propensity for destruction are unquestionably great, and excites in the inhabitants of the territories near its haunts a high degree of terror. It lies in wait near the banks of rivers, and with a sudden spring, seizes any animal that approaches within its reach, swallowing it by an instantaneous effort, and then rushing back into its watery recesses, till renewed appetite stimulates the renewal of its insidious exertions. These animals were occasionally exhibited by the Romans among their collections of the natural wonders of the provinces, and Scaurus and Augustus are both recorded to have entertained the people with the sight of these new and formidable objects. It is reported by some travellers, that crocodiles are capable of being tamed, and are actually kept in a condition of harmless domestication at the grounds and artificial lakes of some African princes, chiefly as appendages of royal splendour and magnificence. A single negro will often attack a crocodile, and by spearing it between the scales of the belly, where it is

easily penetrable, secure its destruction. In some regions these animals are hunted by dogs, which, however, are carefully disciplined to the exercise, and are armed with collars of iron spikes. Aristotle appears to have been the first who asserted that the under jaw of the crocodile was immovable, and from him the idea was transmitted and believed for a long succession of ages. But the motion of the jaw in this animal is similar to that of all other quadrupeds. The ancients also thought it destitute of a tongue, an idea equally false. The tongue, however, is more fixed in this than in most animals to the sides of the mouth, and less capable therefore of being protruded. The eggs of the crocodile are deposited on the mud or sand of the banks of rivers, and, immediately on being hatched, the young move towards the water, in their passage to which, however, vast numbers are intercepted by ichneumons and birds, which watch their progress. See Amphibia, Plate I. fig. 4.

L. alligator, the alligator, differs from the former species principally in being more smooth on the upper part of the head, and on the snout being much wider and flatter, and rounder at the end. It grows to the length of eighteen feet, and abounds particularly in the torrid zone, but it is found so far north as the river Neus in North Carolina. It is met with both in the fresh and salt parts of rivers, and amidst the reeds along the banks, lurks in ambush for its prey, seizing upon dogs and cattle which approach within the reach of its fatal bound. Alligators are equally formidable in their appearance, and ferocious in their dispositions, seizing both man and beast with almost indiscriminating voracity, and pulling them to the bottom to lessen their means of resistance, and devour them with less interruption. By the close union of the vertebræ, this animal can proceed with celerity only in a straight forward direction, so that the intended victims pursued by them, are enabled to elude this destination by lateral and cross movements. But though the alligator is deficient in flexibility, it supplies this defect in a great degree by sagacity or cunning, and appearing on the surface of the water like the stock of a tree, he thus attracts various animals within its grasp. Fowls, fishes, and turtle, all are drawn, whether by curiosity or for convenience, towards this object, supposed completely harmless, but from which the jaws of destruction are instantly opened to devour them. Alligators are said to swallow stones and various other substances incapable of affording nourishment, merely to prevent the contraction of their intestines, and thus allay their hunger; and Catesby observes, that, on opening a great number, he has seen nothing but clumps of light wood and pieces of pine tree coal (in one instance a piece of the weight of eight pounds) worn by attrition to a surface perfectly smooth, implying that they had long remained in their bodies. Their eggs are deposited on the banks of rivers, and sometimes in a nest composed of vegetables with considerable care, and are hatched by the sun, and the young ones are not only devoured by fishes and birds, but become the victims often of their own voracious species. In Carolina they seldom attack men or large cattle, but are formidable enemies to hogs. From October to March they continue in the sequestered caverns of the river banks in a state of torpor, re-appearing in the spring with the most violent and terrific noises. Some parts of them are used by the Indians for food, and the flesh is of an attractive whiteness, but has a very strong flavour of musk. The growth of this animal, and of the crocodile, is extremely slow, and both are imagined to be long lived. The alligator of North America is without doubt specifically distinct from that of South America, and the West India Islands. See Amphibia, Plate I. fig 2.

L. iguana, or the great American guana, is found in various parts of America and the West Indies. Its colour is generally green. Its back exhibits the appearance of a saw, and it is distinguished by a pouch under the throat, which it is able to extend or contract at pleasure, and which gives it occasionally an appearance truly formidable. It is formidable, however, only in appearance, being in fact perfectly inoffensive. Its general length is from three to five feet; it inhabits rocks and woods, and subsists on vegetable food and certain species of insects. The guanas deposit their eggs (which have no testaceous covering, and are much valued for food) in the earth, where they may be warmed by the beams of the sun, and leave them to be matured solely by its influence. The natives of the Bahamas train dogs to the pursuit of these animals, and a well disciplined dog will take them alive, in which case they are carried for sale to the markets of Carolina in the holds of vessels; those which are destroyed or lacerated by the dogs, are salted and barrelled, and kept for the home consumption. Their flesh is re-

ported to be easily digestible, delicate, and well flavoured. They will keep under water for nearly an hour; when they swim, their feet are kept close to their bodies, and they appear to produce and regulate their motions merely by their tails. Whatever they eat they swallow whole. They have been kept without food a very considerable time. Their colour is much affected by the state of the weather, or the dampness or dryness of their habitation. They may be easily tamed if taken young.

L basiliscus, or the basilisk, is particularly distinguished by a broad wing-like process, elevated along the whole length of its back, somewhat similar to the fins of fishes, and which is capable, at the pleasure of the animal, of being extended or contracted. It lives almost solely in trees, feeding upon insects, and though somewhat terrific in appearance, is as harmless as any of the lizard tribe. It is found most frequently in South America, generally about a foot and a half long, swims with great ease, and moving among the branches of the trees with extreme agility, sometimes apparently with a short flight, which is aided by the remarkable process above mentioned, on its back. The basilisk of antiquity, whose bite was supposed to be more speedily mortal than that of any other creature, and whose look even carried destruction with it, is to be ranked with the fabulous monsters, which, in the prevailing ignorance of nature that attended those times, were amply supplied by a poetic imagination. See Amphibia, Plate I. fig. 3.

L. monitor, or the black lizard, measures frequently four and sometimes five feet, being one of the largest as well as the most elegant of the tribe. It is found principally in woody and moist situations in South America, and is reported to give indications of attachment and gratitude to those by whom it has been fed, and familiarised to be as mild in its manners and temper as it is elegant in its form.

L. agilis, or the green lizard, is abundant in all the warmer latitudes of Europe, sometimes attaining the length of more than two feet, but in general not exceeding one. Its colouring is more beautiful than that of any of its tribe in this quarter of the world. About the southern walls of gardens, it is particularly seen pursuing insects with great alertness and dexterity, and both in attack and escape its agility is truly admirable. It may to a certain degree be tamed and familiarised, and in this state is by many considered not only as a perfectly harmless, but as a favourite animal.

L. chamæleon, the chameleon, is generally of the length of ten inches without the tail, which is equally long. Its food consists of insects, which it procures by protruding the tip of its tubular and lengthened tongue with inconceivable celerity, and never failing to retract with it the prey at which it was darted. In India and Africa, and various other parts of the world, these animals are found in great abundance. They are perfectly inoffensive, and can endure a long abstinence, from which latter circumstance the idea of their living upon air alone, may not unnaturally have been derived They occasionally retain the air in their lungs for a very considerable time, and thus assume an appearance of fulness and fleshiness, which is in perfect contrast to that which they will suddenly exhibit, in consequence of the total expulsion of the air from the lungs, during which they are collapsed and seemingly emaciated. A change of colour is sometimes observed in many of the lizard tribe, but particularly so in the chameleon; but the long prevailing idea of the adaptation of its colour to that of any substance with which it is surrounded is totally groundless. Its varieties in this respect appear to extend (in consequence, principally, of varied health or temperature) from its natural green-gray into very pale yellow, with irregular patches of red. When exposed to the sun, considerable changes in the shading and patching of its colours are observable; and when, after being wrapped in white linen by some members of the French Academy, it reappeared within two or three minutes, it partook somewhat, but very far from completely, of the colour of it. On being folded up in substances of various other different colours, it borrowed neither of them, and exhibited no interesting change. The movements of the chameleon are extremely slow, and in passing from branch to branch its tail is coiled for security round one till its feet have been extended to the other.

L. salamandra, or the salamander, is of a deep brilliant black colour, varied with irregular patches of bright yellow. It is found in various parts of France, Germany, and Italy, abounding particularly in moist and woody situations, and making its appearance chiefly during rain. In winter it secludes itself in clefts, or hollow trees. It is about seven inches long, lives principally upon insects and snails,

can subsist by water as well as land, is slow in its movements, and lethargic in its habits. The idea of its being capable of enduring fire without injury, can be accounted for merely from its possessing a power of exuding, in any state of irritation, a white and glutinous substance, which must of course tend to render the application of fire less immediately destructive to it than to some other animals; and considering what trifling causes have led, in innumerable cases, to important inferences, this fact may probably have given rise to the notion of the salamander being insusceptible of destruction, and even of injury, in the midst of flames. The idea of its poisoning any large animal by its bite is equally exploded. The common lizard, however, is stated to have been poisoned in consequence of the bite of the salamander, from some particular fluid contained in the skin of the latter. The salamander produces its young living, hatched from internal eggs, and frequently upwards of thirty in number.

L. aquatica, or the common water newt, is generally about three inches and a half in length, and is found in Great Britain in almost all its stagnant waters. Newts frequently cast their skins with the most complete wholeness, even to the exquisitely delicate and filmy coverings of the eye. In the power of reproduction they resemble the cancer genus. The loss of a leg is reported by Dr. Blumenbach to be easily repaired by renovation, and it is added that the same circumstance occurs with respect to the eyes. The tenaciousness of life exhibited by these animals is remarkable. They have often been found inclosed in large masses of ice, in which they must have been confined for days, weeks, or even, in some instances, for months; and, on being freed from their prison, have soon displayed all the alertness and vigour of perfect health.

LACHENALIA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Asphodeli, Jussieu. Essential character: corolla six-parted; the three outer petals difform; capsule three-winged; cells many-seeded; seeds globular, affixed to the receptacle. There are twelve species, all bulbous rooted plants, and natives of the Cape of Good Hope.

LACHES, in law, signifies slackness or negligence; as when we say, "there is a laches of entry," it means the same as to say, there is lack or neglect of entry.

LACHNÆA, in botany, a genus of the Octandria Monogynia class and order. Natural order of Vepreculæ. Thymeleæ, Jussieu. Essential character: calyx none; corolla four-cleft, with an unequal border; seed one, like a berry. There are two species, *viz.* L. eriocephala, woolly-headed lachnæa; and L. conglomerata, cluster-headed lachnæa; these are both shrubs, and natives of the Cape of Good Hope.

LACHRYMAL, in anatomy, an appellation given to several parts of the eye, from their serving to secrete the tears. The lachrymal gland is situated in the orbit above the smaller angle, and its excretory ducts under the upper eye-lid: these are much more easily demonstrated in the eye of an ox than in a human one.

LACIS, in botany, a genus of the Polyandria Digynia class and order. Essential character: calyx none; corolla none; filaments winged on both sides below; receptacle girt, with twelve spines; capsule ovate, eight-streaked, one-celled, two-valved, many-seeded. There is but one species, *viz.* L. fluviatilis; this plant is called by the natives mourerou; it is a native of Guiana, and has been found only on the rocks of the great cascade of the river Sinemari; it is always under water, except the flowering branches; it is attached to the rocks by packets of small fibres.

LACISTEMA, in botany, a genus of the Monandria Digynia class and order. Essential character: calyx scale of the ament; corolla four-parted; filaments bifid; berry pedicelled, one-seeded. There is but one species, *viz.* L. myricoides, found in Surinam and Jamaica.

LACTATES, combinations of earths and alkalies, &c. with the Lactic *acid*, which see.

LACTEAL *vessels*, in anatomy, fine subtle canals situated in the intestines and mesentry, and serving to convey the chyle to its destined place. See Chyle.

LACTESCENT, in botany, a term applied to the juices of plants, of whatever colour, which flow out of plants, when any injury is done them. The colour is either white, as in the campanula, maple, dandelion, &c.; or yellow, as in the celandine, &c.; or red, as in the bloody dock. Most latescent plants are poisonous, excepting those with compound flowers, which are generally of an innocent quality.

LACTIC *acid*, in chemistry, is contained in milk, and was discovered by Scheele, to whom modern chemistry is indebted for much important knowledge. The formation of this acid depends on the change of the saccharine mucous matter; for

after the acid is once well formed, when the serous part of the milk reddens vegetable blues, no more is obtained by evaporation and crystallization. Scheele obtained this acid by the following process: he evaporated sour whey to one-eighth of its bulk, and then filtered it to separate the coagulated cheesy matter. He then added lime water to precipitate the phosphate of lime, and diluted the liquid with pure water. He next precipitated the excess of lime by means of the oxalic acid, and then evaporated the solution to the consistence of honey, poured on a quantity of alcohol, which separates the portion of sugar, of milk, and other extraneous matter, and dissolves the lactic acid, and distilled the clear filtered liquor till the whole of the alcohol employed be driven off: what remains is the lactic acid. This acid is never crystallized, but always appears in the form of a viscid mucilaginous substance; it has a sharp taste; it reddens tincture of turnsole; and gives a reddish shade to the syrup of violets. It combines with alkalies, earths, and metallic oxides; and forms with them lactates.

LACTUCA, in botany, *lettuce*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx imbricate, cylindrical, with a membranaceous margin; receptacle naked; seeds even, with a simple stipitate down. There are eleven species, of which L. sativa, the common garden lettuce, with its several varieties, are too well known to need a particular description.

LACUNAR, in architecture, an arched roof or ceiling, more especially the planking or flooring above porticos and piazzas.

LADDERS, *scaling*, in the military art, are used in scaling when a place is to be taken by surprise. They are made several ways; sometimes of flat staves, so as to move about their pins and shut like a parallel ruler, for conveniently carrying them: the French make them of several pieces, so as to be joined together, and to be capable of any necessary length: sometimes they are made of single ropes knotted at proper distances, with iron hooks at each end, one to fasten them upon the wall above, and the other in the ground; and sometimes they are made with two ropes, and staves between them to keep the ropes at a proper distance, and to tread upon. When they are used in the action of scaling walls, they ought to be rather too long than too short, and to be given in charge only to the stoutest of the detachment.

The soldiers should carry these ladders with the left arm passed through the second step, taking care to hold them upright close to their sides, and very short below, to prevent any accident in leaping into the ditch. The first rank of each division, provided with ladders, should set out with the rest at the signal, marching resolutely with their firelocks slung, to jump into the ditch; when they are arrived, they should apply their ladders against the parapet, observing to place them towards the saliant angle rather than the middle of the curtain, because the enemy has less force there. Care must be taken to place the ladders within a foot of each other, and not to give them too much nor too little slope, so that they may not be over-turned, or broken with the weight of the soldiers mounting upon them. The ladders being applied, they who have carried them, and they who come after, should mount up and rush upon the enemy sword in hand; if he who goes first happens to be overturned, the next should take care not to be thrown down by his comrade; but on the contrary, immediately mount himself, so as not to give the enemy time to load his piece. The success of an attack by scaling is infallible, if they mount the four sides at once, and take care to shower a number of grenades among the enemy, especially when supported by some grenadiers and picquets, who divide the attention and share the fire of the enemy.

LADEN; the state of a ship when she is charged with a weight or quantity of materials equal to her tonnage or burthen. If the goods with which she is laden be extremely heavy, her burthen is determined by the weight thereof; but if light, she carries as much as she can stow for the purposes of navigation. As a ton in measure is generally estimated at 2000 pounds in weight, a vessel of 200 tons ought accordingly to carry a weight equal to 400,000 pounds; therefore, when the matter of which the cargo is composed is specifically heavier than the water in which she floats; or, in other words, when the cargo is so heavy that she cannot float high enough with so great a quantity of it as her hold will contain, a diminution thereof becomes absolutely necessary.

LAETIA, in botany, so named from John de Laet of Antwerp; a genus of the Polyandria Monogynia class and order. Natural order of Tiliaceæ, Jussieu. Essential character; calyx five-leaved; corolla five-petalled, or none; fruit one-celled, three cornered; seeds with a pulpy aril. There

are four species, of which L. guidonia is a tree which grows to a considerable size in Jamaica, and is esteemed highly for its fine timber, which is much used in all sorts of building; in the fruit of this tree, the lines between the valves are of a beautiful red colour, as well as the placentæ; the filaments of the flower are very numerous.

LAGERSTROEMIA, in botany, so named from Magnus Lagerstroem, of Gottenburgh; a genus of the Icosandria Monogynia class and order. Natural order of Salicariæ, Jussieu. Essential character: calyx six-cleft, bell-shaped; petals six, curled; stamina very many, the six outer thicker than the rest, and longer than the petals. There are four species, of which L. indica, according to Linnæus, is a tree the size of a pomegranate, with opposite leaves, sub-sessile, oblong, quite entire, smooth; the floral leaves roundish; flowers flesh-coloured, in a loose terminating thyrse, on trifid or three-flowered pedicles; the petals, on long claws, six in number, curled and waved. Native of the East Indies, China, Cochin China, and Japan.

LAGOECIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: involucre universal, and partial: petals bifid; seeds solitary, inferior. There is but one species, *viz.* L. cuminoides, wild or bastard cumin: this is an annual plant, about a foot high; the leaves resemble those of honeywort: the flowers are collected into spherical heads, at the extremity of the stalks, and are of a greenish yellow colour. Native of the Levant.

LAGUNŒA, in botany, so called from Andreas Laguna, a Spanish physician and botanist; a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character; calyx simple, five-cusped; style simple; stigma peltated; capsule five-celled, five-valved. There are three species, of which L. aculeata, prickly lagunœa, has a round tomentose stem, armed with small upright prickles, a little branched, and is about a foot and a half in height; leaves alternate, shorter than the petioles, deeply divided into three serrate-toothed segments, the middle one longer than the others; flowers on short peduncles; calyx tomentose, terminating in five short awl-shaped points, bursting on one side to the middle, when the corolla expands, which is yellow, and twice as long as the calyx; filaments short, scattered over the whole surface of the tube; stigma red, peltate, scarcely standing out; capsule oblong, acuminate, five-cornered, tomentose; seeds kidney-form, black. It is a native of Coromandel, near Pondicherry, where it is called by the inhabitants, Cattacacheree.

LAGURUS, in botany, a genus of the Triandria Digynia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx two-valved, with a villose awn; corolla having, on the outer petal, two terminating awns, and a third dorsal one, twisted back. There is but one species, *viz.* L. ovatus, an annual grass, eighteen inches or more in height; very soft and hoary, as are also the leaves and spikes. Native of the South of Europe.

LAKE, in the arts, is a combination of colouring extract, with an earth, or metallic oxide, formed by precipitation from the solution of the colouring matter. If a solution of alum is added to an infusion of madder, a mutual decomposition takes place, and part of the alumine falls united with the colouring matter of the madder. Precipitates, of different shades of colour, are obtained with alum, nitre, chalk, acetate of lead, and muriate of tin. The lakes form some of the beautiful pigments, and are highly esteemed in water-colour painting, and other purposes: and they are almost invariably composed, either of alum, or sometimes the solutions of tin, and some other watery solution of a colouring matter. See Colour.

LAMA, the sovereign pontiff, or rather god of the Asiatic Tartars, inhabiting the country of Barantola. The Lama is not only adored by the inhabitants of the country, but also by the kings of Tartary, who send him rich presents, and go in pilgrimage to pay him adoration, calling him *Lama congiu, i. e.* god, the everlasting father of heaven. He is never to be seen but in a secret place of his palace, amidst a great number of lamps, sitting cross-legged upon a cushion, and adorned all over with gold and precious stones; where, at a distance, they prostrate themselves before him, it not being lawful for any to kiss even his feet. He is called the Great Lama, or Lama of Lamas, that is, priest of priests: and, to persuade the people that he is immortal, the inferior priests, when he dies, substitute another in his stead, and so continue the cheat from generation to generation. These priests persuade the people, that the Lama was raised from death many hundred years ago, that he has lived ever since, and will continue to live for ever.

LAMB. See Ovis.

LAMINÆ, the thin plates of which any thing consists: hence the epithet laminated, which is applied to those bodies whose texture discovers such a disposition as that of plates lying over one another.

LAMIUM, in botany, *archangel*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: corolla upper lip entire, vaulted; lower, two-lobed; throat with a reflex toothlet on each side. There are thirteen species, several of which are considered as weeds, rather than garden plants. The L. album, white archangel, or dead nettle, is common in hedges, on banks, and by road-sides; flowering in April and May, when it is much resorted to by bees, for the honey secreted in the bottom of the tube, by the gland that surrounds the base of the germ. This plant has a disagreeable smell when bruised. Phalæna Chrysitis, or burnished-brass moth, feeds on it: Linnæus says, the leaves are eaten in Sweden as a potherb, in the spring; no cattle, however, seem to touch it; and, having a strong, creeping, perennial root, it should be extirpated, which is not difficult.

LAMP, *Argand's*. This is a very ingenious contrivance, and the greatest improvement in lamps that has yet been made. It is the invention of a citizen of Geneva; and the principle on which the superiority of the lamp depends is, the admission of a larger quantity of air to the flame than can be done in the common way. This is accomplished by making the wick of a circular form, by which means a current of air rushes through the cylinder on which it is placed with great force; and, along with that which has access to the outside, excites the flame to such a degree, that the smoke is entirely consumed. Thus both the light and heat are prodigiously increased, at the same time that there is very considerable saving in the expense of oil, the combustion being exceedingly augmented by the quantity of air admitted to the flame; and that what in common lamps is dissipated in smoke is here converted into a brilliant flame. This lamp is now very much in use; and is applied not only to the ordinary purposes of illumination, but also to that of a lamp furnace for chemical operations, in which it is found to exceed every other contrivance yet invented. It consists of two parts; *viz.* a reservoir for the oil, and the lamp itself. The reservoir is usually in the form of a vase, and has the lamp proceeding from its side. The latter consists of an upright metallic tube, about one inch and six-tenths in diameter, three inches in length, and open at both ends. Within this is another tube, about an inch in diameter, and nearly of an equal length; the space betwixt the two being left clear for the passage of the air. The internal tube is closed at the bottom, and contains another similar tube, about half an inch in diameter, which is soldered to the bottom of the second. It is perforated throughout, so as to admit a current of air to pass through it; and the oil is contained in the space betwixt the tube and that which surrounds it. A particular kind of cotton cloth is used for the wick, the longitudinal threads of which are much thicker than the others, and which nearly fills the space into which the oil flows; and the mechanism of the lamp is such, that the wick may be raised or depressed at pleasure. When the lamp is lighted, the flame is in the form of a hollow cylinder; and by reason of the strong influx of air through the heated metallic tube becomes extremely bright, the smoke being entirely consumed, for the reasons already mentioned. The heat and light are still farther increased, by putting over the whole a glass cylinder, nearly of the size of the exterior tube. By diminishing the central aperture, the heat and light are proportionably diminished, and the lamp begins to smoke. The access of air both to the external and internal surfaces of the flame is indeed so very necessary, that a sensible difference is perceived when the hand is held even at the distance of an inch below the lower aperture of the cylinder; and there is also a certain length of wick at which the effect of the lamp is strongest. If the wick be very short, the flame, though white and brilliant, emits a disagreeable and pale kind of light; and if very long, the upper part becomes brown, and smoke is emitted. The saving of expense in the use of this instrument for common purposes is very considerable. By some experiments it appears, that the lamp will continue to burn three hours for the value of one penny; and the following was the result of the comparison between the light emitted by it and that of a candle. The latter having been suffered to burn so long without snuffing, that large lumps of coaly matter were formed upon the wick, gave a light at 24 inches distance equal to the lamp at 129

inches: whence it appeared, that the light of the lamp was equal to 28 candles in this state. On snuffing the candle, however, its light was so much augmented, that it became necessary to remove it to the distance of 67 inches, before its light became equal to that of the lamp at 129 inches: whence it was concluded, that the light of the lamp was somewhat less than that of four candles fresh snuffed. At another trial, in which the lamp was placed at the distance of 131½ inches, and a candle at the distance of 55 inches, the lights were equal. In these experiments the candles made use of were 10¾ inches long, and $2\frac{6}{10}$ inches in diameter. When the candle was newly snuffed it appeared to have the advantage; but the lamp soon got the superiority; and on the whole it was concluded, that the lamp is at least equivalent to half a dozen of tallow candles, of six in the pound; the expense of the one being only 2½*d.* and the other 8*d.* in seven hours.

We shall now give a more particular description of Argand's lamp, with reference to figures. Fig. 1, Plate Argand's Lamp, is an upright elevation; fig. 2, a section; and figs. 3, 4, and 5, parts of this useful instrument. A A (fig. 1 and 2) is a reservoir containing oil, whose shape is immaterial; in the present instance it is that of an urn: B is a tube to convey the oil to the lamp, where it is consumed. The lamp is composed of several tubes, one within the other: the external, *a a*, is only a case to defend the others within it, having a small cup, *b b*, screwed to it at bottom, to receive the dropping of oil: at *d* the tube is enlarged by a projection soldered to it, and into which the tube B delivers the oil it brings from the urn A A: *e e* (fig. 2) is the second tube, supported concentrical with the other by the enlargement *d*, which it is open to all down one side; the oil, therefore, has free passage into this tube; but as it is closed at bottom, and the cavity, *d*, tight, it cannot get in the external tube, *a a*: *f f* is the internal tube, supported by being soldered to the bottom of the second, *e e*: another moveable tube is placed between the tube *e e* and *f f*, as seen in the section (fig. 2), but better explained in a separate figure (fig. 4), where *g h* is the tube; it is divided by a slit from top to bottom on the side *g*; on each side of this slit a small piece of brass plate, *i*, is soldered to support a frame, *k*, in which a small pinion works (as shewn in fig. 2); this pinion gives motion to a rack, *l*, (fig. 5) bent at right angles at the lower end, and holding a short tube, or rather ring, *m*, on which the wick, *n*, is held; this ring and the wick slide within the tubes *g h*, and outside of the internal tube, *f f*, its arm connecting it with the rack, *l*, goes first through the slit down the side, *g*, of the tube (fig. 4), and next through the opening in the side of the tube, *e e*, where it communicates with the cavity *d*. At the top of the lamp a glass chimney, *o o*, is fixed, (as shewn in fig. 3), where *o o* is the glass tube, with a small enlargement or ring at the bottom: *p p* is a brass ring going over the glass, and catching the rim at the bottom; it is cut into a female screw withinside, and screwed upon another ring, *r*; this presses against the bottom edge of the glass tube, and thus holds it fast between them: the ring *r* fits tight by friction upon the top of the tube, *a a*; but so as to be easily removed when the glass is to be cleaned or taken away. The great advantage of this lamp is, that the wick is hollow, and the air brought to it, both on the inside by the tubes *f f*, and outside between the tubes *e e* and *a a*, and by the rarefaction of the air in the glass chimney, a considerable draught is created, and the air forming, which is forced to pass through the flame. In the urn, A, is a contrivance to regulate the quantity of oil coming from it, that the lamp may not be overflowed: it unscrews at *t*, (fig. 2) and terminates below the screw in a small pipe, *v*, closed at bottom: a hole is made in the side of this pipe, through which the oil flows: it is closed occasionally by a small tube sliding upon the other, *v*, and moved by a small handle, *t*, coming through the screw, *t*: a small hole should be drilled through the screw in the same direction as the wire of the handle, *t*, to supply air to this part. When the urn is to be filled with oil, it is unscrewed at *t*, and the oil poured in at the hole in tube *v*: the hole must then be closed, by pushing down the handle, *t*: the oil cannot now get out, and the urn is screwed into its place; when the handle, *t*, is pushed down, the hole is opened by removing the tube, *u*, from before the hole in the pipe, *v*: the oil now runs out, the air entering at the same hole, until it rises in the cistern at the end of the pipe, B, above the level of the hole; the air cannot now enter, and consequently the oil will not come out, until by the burning of the lamp the oil is drawn down below the hole; a bubble of air then gets into the

urn, and an equivalent drop of oil runs down: by this means, though the lamp is always plentifully supplied, yet it never runs over.

LAMP *black*. See Colour.

LAMPYRIS, in natural history, *fire fly*, a genus of insects of the order Coleoptera. Antennæ filiform; four feelers; shells flexile; thorax flat, semi-orbicular, surrounding and concealing the head; segments of the abdomen terminating in folded papillæ: female usually apterous. There are nearly sixty species, in four divisions, *viz*. A. feelers subclavate: B. fore-feelers hatchet-shaped: C. feelers sub-filiform: D. first joint of the feelers thicker and truncate. The first of these divisions is subdivided into those which have entire horny lips; and into those with an emarginate membranaceous lip. The body of the insect in this genus is oblong, with the sides formed into a kind of soft papillæ, lapping over each other. L. noctiluca, or glow-worm, is seen during the summer months, in England, on dry banks, about woods, pastures, and hedgeways, exhibiting, as soon as it is dusk, vivid and phosphoric splendour, in form of a round spot of considerable size. The animal itself, which is the female insect, measures about three quarters of an inch in length, and is of a dull, earthy-brown colour on the upper parts, and beneath more or less tinged with rose colour, with the two or three last joints of the body of a pale or whitish sulphur colour. It is from these parts that the phosphoric light proceeds. The body, exclusive of the thorax, consists of ten joints. The larva and pupa do not greatly differ from the complete insect, but the phosphoric light is strongest in the complete animal. The male is smaller than the female, and is provided with wings and wing-sheaths: it is very uncommon; and it is not determined whether it be luminous or not. Naturalists have commonly supposed, that the splendour of the female is designed for the purpose of attracting the male. In Italy, the flying glow-worm is extremely common; and it is said that, on grand occasions, ladies use them as ornaments for their head-dresses in evening parties.

LANA, in botany, *wool*, a species of pubescence, down, or velvet, which serves to screen the leaves covered with it from the heat: this appearance is very conspicuous in the horehound, woolly thistle, &c.

Lana *philosophica*, flowers of zinc. See Zinc.

LANARIA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: corolla superior, woolly, longer than the filaments; border six-parted, somewhat spreading; capsule three-celled. There is but one species, *viz*. L. plumosa, woolly lanaria, a native of the Cape of Good Hope.

LANCET, a chirurgical instrument, sharp-pointed, and two-edged, chiefly used for opening veins in the operation of phlebotomy, or bleeding; also for laying open abscesses, tumours, &c.

LANGUAGE. 1. Man, it has frequently been said, is the only animal possessed of speech, and if we use this term as implying the expression of a train of ideas by articulate sounds, it may perhaps be esteemed the best criterion of distinction between man and the inferior animals. It is not easy to fix upon one which shall be universally applicable; but the same difficulty frequently occurs in the attempt to ascertain the exact boundary between the characteristics of one class of being and those of another: for instance, the naturalist finds it a puzzling problem to ascertain the characteristic difference between the animal and the vegetable kingdom. Some of the most intelligent of the brute creation often astonish us by actions, which can proceed only from powers of intellect similar to those which we possess. All the mental powers, except sensation, are probably the modifications of the principle of association: it is acknowledged that brutes possess this in a considerable degree, and it is probable, that to the difference in the extent of this principle of its activity and direction we are to attribute the mental difference between one animal and another. There is, perhaps, less difference between the most uninformed mind of the human species and the most sagacious of the brutes, than between the brightest ornaments of our race and those whose minds have received the least culture from natural or artificial education. We gain greater exactness by making the capacity of speech the criterion of distinction between man and the brute creation. Many animals are capable of acquainting others of the same, and even of a different species, with the feelings of their minds; but man alone has the power of expressing a train of ideas, and of stating the causes of those feelings.

2. Articulation furnishes the most convenient and extensive method of communication. It would be possible to form a language of signs, and in many instances

this is done; but human thought would never have acquired any high degree of accuracy and extent, if there had been no other language. The most perfect language of signs is merely a representative of the language of speech. What are called the natural signs of feeling are very similar to the language of brutes, and not more extensive. To give speech all the energy of thought, the language of tone and gesture must be joined to it; but it will generally be found that those who have words for all their ideas, seldom have recourse to gesticulation, except when the warmth of feeling calls it forth. Where speech is defective in energy, it is usually enforced by looks, gestures, and tones: these powerfully appeal to the feelings, because they are considered as an indication that certain feelings exist in the mind of the speaker, and feeling is contagious; but our limits will not allow us to enter into the consideration of this species of language, and we shall confine ourselves to that of speech, at the same time begging our readers to refer to the article Voice for an account of the mechanism by which speech is effected, and to Writing, *origin of*, *alphabetical*, for the methods which men have adopted for a permanent visible denotement of speech, which latter we wish to be considered as forming one with the present article.

3. Whatever be our opinion respecting the progressive melioration of brutes, if the capacity of language were communicated to them, there can be no hesitation in admitting that there would be a progressive deterioration of the human species, if they were deprived of it. Had not man possessed this, or some other extensive power of communication, that astonishing system which we call the human mind, would have remained in inactivity, its faculties torpid, its energies unexcited, and that capacity of progressive improvement which forms so important a part in the mental constitution, would have been unknown and given in vain. But in every part of the creation we discern an unity of design, which equally proves the wisdom and benevolence of the great First Cause. The means of bringing his powers into activity are bestowed upon man, as well as the powers themselves; and it is a position which will bear a rigorous examination, that the accuracy of human thought, and the extent of human intellect, generally proceed in equal steps with the accuracy and extent of language. When we consider the influence of language upon intellect, it will not appear too much to affirm, that if those, whose genius has dazzled the world with its splendour and extent, had been from the first destitute of the power of communication, they would not have risen above the level of the least cultivated of their fellow mortals. "Conceive such a one (to use the ideas of Condillac) bereft of the use of visible signs, how much knowledge would be concealed from him, attainable even by an ordinary capacity. Take away from him the use of speech, the lot of the dumb teaches you in what narrow bounds you enclose him. Finally, deprive him of the use of all kinds of signs, let him not know how to make with propriety any gesture, you would have in him a mere idiot."

4. We are far, however, from believing, with Lord Monboddo, that the human race have actually risen from the very lowest stage—that of mere brutality. His lordship supposes, on the authority of several travellers whom he quotes, (and of whose passion for the marvellous his quotations leave no room to doubt), that there have been nations without laws or any of the arts of civilized life, without even language; and that some of them (to complete their resemblance to the monkey tribe) had actually tails. This, with other opinions which display rather the credulity of the man of system, than the sober and cool judgment of the philosopher, has exposed his lordship to the lively ridicule of Mr. Horne Tooke; and though ridicule is no test of truth, we must admit that this is one of those dogmata which it is below the dignity of reason to refute.

5. We see in language a complicated whole, which we are usually accustomed to consider as it is, without attempting to ascertain what it has been. We see all regularity and beauty, and we do not often ask ourselves the question, has language always been thus regular and beautiful? When we look back into the earlier periods of human nature, we find that this, which now wears so much the appearance of art, was originally the invention of necessity, gradually perfected and brought into a systematic form by causes which have operated generally, but have received modification from the influence of local or temporary circumstances. A complete history of the origin and progress of language, would be a history of the human mind. Our direct evidence is not very extensive, and indeed

we are too much obliged to have recourse to hypothesis in tracing the progress of improvement in any department of science. We are unable always to ascertain (as Mr. Stewart observes) how men have actually conducted themselves on particular occasions, and we are then led to inquire in what manner they are likely to have proceeded, from the principle of their nature, and the circumstances of their external situation. In such inquiries the detached facts which the remains of antiquity, or the narrations of travellers, or the actual appearances of language at present, afford us, serve as landmarks for our speculations. "In examining the history of mankind, as well as in examining the phenomena of the material world, when we cannot trace the process by which an event *has been* produced, it is often of importance to be able to show how it *may have been* produced by natural causes. The steps in the formation of language cannot probably be determined with certainty; yet if we can show, from the known principles of human nature, how all its various parts might gradually have arisen, the mind is not only to a certain degree satisfied, but a check is given to that indolent philosophy, which refers a miracle whatever appearances both in the natural and moral worlds it is unable to explain."

6. Diodorus Siculus and Vitruvius supposed, that the first men lived for some time in the woods and caves, like the beasts, uttering only confused and inarticulate sounds; till, associating for mutual assistance, they came by degrees to use articulate sounds, mutually agreed upon, for arbitrary signs or marks of those ideas in the mind of the speaker, which he wanted to communicate to the hearer. By what degrees they proceeded from inarticulate to articulate sounds, these writers do not attempt to point out, and unless we admit that those articulate sounds were connected with certain feelings, in the same manner as what are called the natural signs, or, that they were easily produced, (which will not be allowed by any who have attended to the structure of the organs of speech) the account we have received from a better informed historian will not lose its ground. Moses leads us to understand that the rudiments of language were given to man by his Maker. Here was the first step, and here it is reasonable to believe the divine communication ceased, and that man was left to complete what he had been taught to begin. Let us then suppose the use of articulation given, and its application in some instances pointed out, in the invention of the names of animals; which, we may observe, is in fact the first step which would probably have been taken, presupposing the use of articulation, if no divine interposition had taken place.

7. Words would originally be simply the signs of things, and further, of individuals. New objects, for which necessity required a name, would receive different names from those already given; but if there were a striking similarity between a new object, and one which had already received a name, the old name would be transferred. One of the principles of association is similarity, and the new impression would recal the idea of a former object which it resembled, and consequently the word with which that object was connected; and thus, what originally was a name for an individual only, would gradually become the name of a multitude. Thus Lee Boo, who had been taught by his fellow voyagers to call a great Newfoundland dog by the name of *Sailor*, used to call every dog he saw *Sailor*. There is little or no difficulty attending the appellation and classification of sensible objects: it is an operation simple and easy, if some articulate sounds were known.

8. When several objects had received the same name, it would sometimes be necessary to distinguish them. Our procedure in such cases is, to connect with the name of the object the name of a distinguishing quality, or some word of a restrictive force, or to specify some relation which it has with other objects; but this supposes that to be already done, which we must suppose is to be done. Now we must bear in mind that similarity (sensible, external similarity) and local connection, are those principles of association which are known to be most active in the minds of the illiterate and uncultivated, and that they must also have been the most active in the minds of all men in the rude states of society. A peculiar colour (which would furnish one criterion of distinction) would, therefore, suggest the idea of some object remarkable for that colour; and the name of this second object, joined with the name which the first had in common with others, would confine this general term to the particular object which it was intended to specify. This is a procedure so simple, that we may expect to find some traces of it still remaining to us; and accordingly, among others, we have the expression,

an orange ribbon, which will exemplify what has been said: if we wish to distinguish a ribbon by its colour, we are in this case able, agreeably to the custom of our language, to connect with the word ribbon, the name of an object remarkable for that colour. It must however be observed, when tracing out other examples of this contrivance, and the application of it to other qualities, that *sensible* qualities were those, and those only, which would be first noticed, and most requisite to be noticed. Local situation, or vicinity to some object, would furnish another ground for distinction; the fountain near the cave, for instance. Now to express this, the procedure would be simple and intelligible, if, immediately preceding or following the term denoting *fountain,* the term denoting *cave* were added; in like manner as we at present use the expressions, *barn-yard,* &c. This juxtaposition of the signs, to signify the contiguity or similarity of the objects which they denote, is natural, and, in a language little extended, sufficiently adequate for all the purposes of common life: but it is obvious that it would allow of great latitude of interpretation; and hence, as languages became more copious, contrivances were used to denote the nature of the connection which existed between objects denoted by the signs employed. The chief of these is the employment of prepositions; and these, in the outset, furnish additional proof that the procedures we have spoken of were in reality those of the early framers of language, (see GRAMMAR, § 41, particularly respecting *from*); but these were contrivances of a later date than those of which we here speak. By degrees it was by some tribes found convenient to designate those names which were employed in connection with other names to point out some quality or restricting circumstance of the thing signified, by some note that they were so employed. They might without any disadvantage have left the inference to simple juxtaposition; but this appears to have been done in few languages after improvements began to take place: and to effect such designation, words (in some cases denoting *add, join,* &c.) were subjoined to the particularizing names, and they then became adjective. (See GRAMMAR, § 22.) The Chinese, however, make no distinction between words when employed as nouns and as adnouns; the same word when placed first being an adjective, and when placed last, a substantive. We do the same in many instances; but a large proportion of our simple adjectives are formed as above, and are never employed as substantives; the Chinese, on the other hand, when a substantive is not to be used adjectively, add a designating syllable to it.

9. As far as respects sensible objects and their connections, all seems very plain: in order to express objects which were not sensible, so as to convey to others the feelings which existed in the mind of the speaker, words were used which had previously been appropriated to objects, to which those objects of the mind's eye appeared to have some resemblance or other connection. This resemblance or connection was frequently forced, and to those whose situation was different would not be at all striking; in other cases it was correct, and the justness of the application is proved by a similar procedure of unconnected inventors. We may derive great light here from the hieroglyphics: for there cannot be a doubt, that where the visible sign, which originally represented only a sensible object, was applied to denote some quality discovered by reasoning and observation, that the audible sign or word was applied in like manner. Several instances will be adduced when we come to consider the hieroglyphical mode of communication: at present we shall adduce one or two examples as illustrations of the principles here stated. The term used to denote the *mouth* would also denote *speech;* this connected with the word *dog,* would signify the *dog's voice;* and this compound the Egyptians employed to signify *lamentation,* and the *sorrow* which produced it. In the uncultivated periods of society, grief is loud and clamorous; and we need not be surprised to find the term *howl* employed to denote the exclamations of pain, and even of sorrow. By a similar, but more obvious procedure, the words *dog, field,* placed together, denoted *hunting.* Our readers will be able, even in the present refined period of our language, to trace numerous instances in which the names of intellectual things have been obviously transferred from sensible things; and to those who have attended to the subject it will not appear too much to affirm, that in every instance, where a word is not the name of a sensible object, it has acquired its present force by a gradual transition from its primary application to sensible objects. In every known language the transition has been begun; but it is only among the more refined that it has been complete: in our own, we find abundance of instances in almost every intermediate

stage of the progress, as well as in its termination.

10. Language would proceed but awkwardly without those wheels which have been gradually made for it: but all which can be thought necessary for communication, are the noun and the verb; and even of the latter the necessity may be justly doubted. We think it next to certain, that the whole of what is now (by association) implied or denoted by the verb, beyond what is denoted by the acknowledged noun, was originally mere inference from the juxtaposition of the verb-noun with another noun. *Men fight*, are names, and are still acknowledged as such; placed together, especially if accompanied by distinguishing tones of voice, it would be naturally inferred that the speaker intended to raise in his hearer's mind that belief which exists in his own; in other words, to direct his hearer to make a connection which circumstances has formed in his own mind. By degrees, at least in some nations, some of those names which were frequently thus employed with the inference of affirmation, became somewhat appropriated to convey this inference, and the inference would then be made whenever such a word was employed; but in the earliest stages of language, the great body of verbs must have been merely nouns, and in the more simple languages many of those words which are employed as verbs (*i. e.* conveying the inference of affirmation) are still immediately recognised as nouns. In the Chinese very few names are appropriated as verbs, but are used indiscriminately, and without any change of form either as nouns or as verbs: in the Hebrew, the root (which does not, like every part of the indicative in the Greek and Latin verbs, include a pronoun) is a simple name, and is in many cases used as a noun; and in our own language many names are used either as nouns or as verbs. When we have advanced to the frequent use and gradual appropriation of some names to convey the inference of affirmation, the rest is easy and almost certain. With respect to the simple affirmation, the subject of it would, in the case of the first and second persons, always be a pronoun, and, in the same district, the same pronoun. This, where *spoken* language made material progress, would gradually coalesce with the verb; and the word so formed would be completely invested with the verbal character, and never be employed but with the inference of affirmation. The same might also be the case respecting the third person; but the coalescence would in this instance be more slowly formed, and in some languages, where the coalescence took place in the other persons, it did not in this: it must however be admitted, that in others the contrary is the fact. But we have already enlarged on these points as much as our limits will permit; and we therefore beg our readers to refer to Grammar, § 29, 33, for some additional remarks respecting those changes which the verb has undergone in order to make it more expressive.

11. We do not think it necessary to enter any farther into the subject of the origin of oral language. It can scarcely be doubted by those who have studied the nature of the other parts of speech, by means of the light which the researches of Mr. Tooke have afforded, that all have been derived from the noun and the verb; and admitting this, all that is incumbent upon those who profess to show the original causes of language is, to present a probable origin of those classes of words. In those procedures which have been here stated, there is nothing which supposes metaphysical research or much observation; and to render any procedure probable, it must wear the marks of simplicity. In the present period of the language, we see the grammarian pointing out the analogies which are found to exist in language, and thence proceeding to the formation of new words upon those analogies: this is art; but the early formers of language, in their inventions, followed only the dictates of circumstances, and whatever regularity we may perceive in their inventions, must be attributed to the similarity of those circumstances. We see the philosopher inventing a new term, agreeably to prevailing analogies, to express some power of the mind, or some emotion which had not received any denomination; but those who originally gave names to mental feelings derived them simply from some analogy, fancied or real, between the internal and an external object: and those names which now suggest to us ideas the most subtle and refined, were originally only the names of objects obvious to the senses. The reasoner, when he uses a word whose meaning has not been accurately ascertained, defines the ideas which he intends to attach to it, and uses it accordingly: in the early, and even in the more refined periods of language, the ideas connected with words have been the result of casual associations, produced by local circumstances, by the customs of

the age, or the appearances of nature in particular situations.

12. In languages, in which the coalescence between the verb and its adjuncts has taken place, and also the coalescence between nouns and its connective words, (Grammar, § 19), much greater liberty of inversion is practicable than in those in which such coalescence has not at all occurred, or but incompletely. In other words, where the noun, adnoun, and verb, admit of flexion, there the arrangement depends in many instances more upon the sound than upon the sense; and nearly in all cases may be made subservient to the former. This gives such languages considerable advantage over those which admit of but few changes, so far as respects their modulation; and further, the coalescence renders them much more forcible, where emphasis on any of the fractional parts is not required. Whenever flexion increases perspicuity, the advantage is decisive and obvious: with respect to modulation, though an object of some consequence, (since we may sometimes find the way to the head and heart by pleasing the ear) yet all cultivated languages will be found to possess sufficient power of pleasing the native ear; and among those who made sound so much an object, sense was often sacrificed to it: with respect to force, it may fairly be doubted whether the advantage of greater precision, by means of more accurate emphasis, does not counterbalance it. We are willing to admit on the whole, that the advantage is somewhat in favour of those languages in which flexion is extensively adopted; but we can by no means admit the opinion of those who think it necessary to a perfect language. That language is not the most perfect, which enables us to express one thought in a great variety of ways, but that which enables us to express any thought with precision and perspicuity: and contemptible as our own uninflected language may appear to those who can think nothing good but what accords with the objects of their early taste, we are disposed to believe that in its real powers it rises beyond all the ancient languages, and beyond most of the modern.

13. Before we leave the subject of oral language, we shall pay some attention to the three following inquiries; whether words were originally imitative; whether they were long; and of what kind of articulations they were composed. The latter of these are of importance in tracing the gradation from hieroglyphical to alphabetical writing. Words, in their present state, are simply arbitrary marks. The sound of some appears to be "an echo of the sense;" but in the greater number of instances in which there is supposed to be this resemblance, very much may be attributed to the fancy of the observer. It is obvious, however, that some words are truly imitative, such *e. g.* as denote the various sounds of animals. When we carry our inquiries farther back, we are led to suppose that the original words would be formed upon some resemblance, real or supposed, between their sound and the thing signified. What else, at first, could induce men to fix upon one sound rather than another? Sensible objects were the first which obtained names; and of these the number is considerable, which either emit some imitable sound, or perform such motions as are generally accompanied with sound. These would probably be denoted by words imitative of the sound, in the same manner as the Otaheitans gave to the gun the appellation of *tick-tick-boo*, evidently imitating the cocking and report of the gun, and as we give the *cuckow* its name from its note. With respect to qualities totally unconnected with sound, particularly mental qualities, this principle of imitation is not directly applicable: we immediately see the incongruity of sound and colour, for instance, when we call to mind the idea of the blind man, that a scarlet colour was very much like the sound of a trumpet. Yet there can scarcely be a doubt that *fancied* resemblances would, as much as real ones, direct the application of names. Some ingenious writers on this subject have observed certain letters applied to denote a certain class of ideas, which have some common features of resemblance, and have inferred that those letters were *significant* of that common feature; *e. g.* that *c* denotes *hollowness*. This particular coincidence arises probably from the circumstance, that the original word denoting hollowness, which has entered variously modified into the words in question, was *c* with some vocal sound. This appears to be the extent of the inference which may be justly drawn; that it was so applied, but not that the sound was significant of the idea. We are accustomed to use sounds in particular connections with such regularity and constancy, that they appear to have a signification of themselves considered; but this inference arises from inattention to the matter of fact. Frequently, from our acquaintance with the sense,

we read a combination of words as the sense dictates, and suppose the imitation in the words, which really exists only in our mode of enunciation; but these instances, however just, afford no ground for argument in the present discussion, which refers only to single words: and with respect to them, we cannot but confine the resemblance of their sound to their sense, to cases in which they denote sound or motion usually accompanied with sound.

14. The chief importance of the inquiry, whether the original words of language were long, is principally confined to that language, in which the transition took place from hieroglyphics to letters. This is usually supposed to have been the Egyptian; but as of this language only a few words are preserved in the Coptic, (of which however a large proportion are monosyllables) we may make the inquiry more general. Lord Monboddo supposes, that the first articulate sounds were imitations of the cries of animals, and that consequently they were of great length, "for such cries of almost all animals have a certain tract or extension: and that we may not think man an exception to this rule, we need only attend to the dumb persons among us, who utter inarticulate cries, sometimes very loud, but always of considerable length." Leaving the latter argument, which surely is nothing to the purpose, we may observe, that if the cries of animals were imitated to denote those animals, great length of words was unnecessary and improbable: unnecessary, because one or two distinct articulations would usually answer every purpose; improbable, because articulation is difficult. If we extend the principle of imitation farther, and suppose the cries of animals imitated by man, in order to express feeling merely, his cries would surely be undeserving the name of words, and at any rate would throw no light on our inquiries. The theory of long words appears to derive confirmation from the vocabularies of the North American Indians. For instance, of three which are given by Mackenzie, two appear to be composed of words of from two to seven syllables, with scarcely any words of one syllable. The third, however, is composed principally of words of one or two syllables. With respect to the former, even where the words actually denote sensible objects, our inference, that they are uncompounded, should be cautiously drawn. The moon is expressed by two words, *tibiscapesim*, *night-sun;* and several others appear to be circumlocutions. The catholic savages on the river St. Lawrence call the priest, *the master of life's man;* and it is very probable that, in uncultivated nations, names of new objects would, where possible, be formed rather by significant combinations of words in use, than by the formation of new words. Thus we learn from Mr. Parke, that the Mandingo nation use the following (among many) circumlocutions: *fruit* is eree-ding, *child of the tree; finger,* boullakon ding, *child of the hand or arm; noon* teeleekoniata, *the sun over head*; *brother*, ba ding kea, *mother's male child*; *proud*, telingabalid, *straight-bodied; angry,* jusu bota, *the heart comes out:* we think it almost unnecessary to remark, how much the last two instances countenance the positions before laid down, respecting the transference of names from external to internal things.

15. The words which Lord Monboddo adduces in proof of his opinion are, wonnaweucktuckluit, *much*, and mikkeuawkrook, *little*, from the Esquimaux; and poellarrarorincourac, *three*, among some South American Indians. The above examples lead us to class the two former among the descriptive circumlocutions with which all languages are filled. With respect to the last, we may observe, that the names of numbers were probably originally significant in all languages; and that the length of those names would depend upon the length of the original words, and the manner of combining them: thus, six is among the Kamschatkans expressed by *innen-milchin,* that is, *five and one.* Numbers are so familiar to us, and so distinctly arranged in groups, that perhaps in no case are our ideas more clear; but this clearness entirely depends upon the distinctness of the signs, and of the manner of using them. We speak of ten and twenty, &c. and all seems very clear; but it is evident, if we attempt to form a conception of ten or twenty things, we must pass over every one singly, and endeavour to combine them by processes which will be varied by the habits of the individual. If we give a fresh name to every group of objects, and then consider those groups as units, and so on, we are capable of extending our ideas of number indefinitely, and of speaking and thinking of them with accuracy: but if the small extent of intellect, or the circumstances of situation, prevents this grouping, and our attention be confined to individuals, our arithmetic must be very confined. Those nations which reckon only by comparison with their fingers, without group-

ing numbers, carry their ideas of number no farther than ten; those who take in the toes, go as far as twenty. The Kamschatkans can count no farther; and when they have advanced to this limit, they say, "where shall we go now?" It is difficult to conceive what circumstances could bound the arithmetic of Lord Monboddo's Indians to three, or rather what should induce them to choose so troublesome a mode of procedure; but it appears highly probable, that they joined together the names of three different men or other animals, and if they had proceeded further (which however Condamine informs us they did not) they would have joined four together, &c. Perhaps their tribe originally consisted of three only; and then, in order to speak of three, they might use the three names combined together, which combination, losing its primary application, would become a general denotement of three.

16. If Lord Monboddo had looked into the vocabulary of the Mexicans, he would have thought that his theory derived great confirmation from their words. Clavizego informs us, that they had words of fifteen or sixteen syllables: but he expressly says they are compounds. He gives one as a specimen of their combinations, *viz.* notlazomahuitzteopixcatalzin; this signifies *my very worthy father*, or *revered priest*, and is compounded of seven words. The language of the Mexicans is very copious; and one cause of the length of their words is probably the deficiency of consonants, which renders a combination of sounds necessary for distinctness. After all, we may admit that the languages of the American Indians favour the hypothesis of long words without any injury, for among them alphabetical writing never existed; and we should have enlarged less on this point, if it had not led us to notice some curious procedures of language: but it seems reasonable to admit, as an inference, that the original or rather the secondary words in language might be long, though not to the degree that Monboddo supposes. When, however, we advance further, and inquire of what kind the original words of man really were, we see sufficient reason to conclude them to be short. Language was first used in the east, and there too writing was invented. Besides the evidence to be derived from the ancient Egyptian (§ 13), we may cite the following. The Chinese, which as far as oral language is concerned, appears to have undergone very little alteration, and to be nearly an original language, is composed entirely of what are at present monosyllables. The original words of the Hebrew, Greek, &c. (that is, those which have not been varied by the addition of other words) are short, frequently only of one syllable, seldom of more than two. And to conclude, of the various vocabularies which we have had an opportunity of consulting, of the uncivilized nations of the east, the words are generally monosyllabic or dissyllabic.

17. Our last object is to consider the position, that, in the early languages, consonant sounds were at least generally accompanied by vowel sounds: but though this is a material point in tracing the transition from hieroglyphics to alphabetical writing, it will not be necessary to enlarge much upon it. We think this position proved by the following, in some measure unconnected, considerations. 1. Vowel sounds are by far the most easy; and consequently they constitute the earliest vocal sounds of children, and a large proportion of the vocal sounds of uncivilized nations. Several words among the South Sea islanders are composed entirely of vowel sounds; and so great is the difficulty which these people find in pronouncing consonants together, that they called Sir Joseph Banks *Opano.* From this consideration we may fairly infer, that vowel sounds would be frequent in the original words of the early languages, which were formed before articulation was become easy. Yet, 2. as the shades of distinction between them, when employed alone or together, are too nice to furnish, at least to the unpractised ear, many obviously different words; and as man was not at first in that low state of intellect in which he has sometimes appeared, a vocabulary formed of such sounds would be very inadequate to his wants; and therefore we must suppose that in the early languages there would be very few words without consonant sounds. 3. Some of the first articulations of man were, without doubt, employed in naming those of the inferior animals with which he was concerned. Now their names would almost certainly be given from their distinguishing cries; and the cries of such animals consist of consonant sounds, each followed by a vowel sound. 4. As articulation would at first be nearly as difficult as we now perceive it to be in children, the first words would be composed of simple articulations, that is, of consonant sounds following each by a vowel; and new words would be formed by the combina-

tion of such words: so that in the early languages all compounds would be formed by the combination of simple articulations. 5. The greater part of consonant sounds cannot be sounded singly without vowels, nor together, without vowels intervening. In many cases this is evident to the ear; and where it is not perceived, it often is the fact, though the acquired rapidity of utterance may render it very little perceptible. 6. Some languages do not admit of any two consonant sounds together. The Tartar language always requires a vowel between two consonants. The Russian, we believe, does the same. The Chinese never join two consonants, unless we must except *ng;* but this appears to be only a simple sound, though represented by two of our letters. With respect to the Chinese the point is of consequence; because there is great reason to believe that they came from the stock of the Egyptians, before there had been any considerable addition to their vocabulary by combinations of sounds, and before the transition had been made from hieroglyphical to alphabetical writing. It is true, many of the Chinese words end in consonants, which seems to render improbable the position advanced: but it is to be observed, that in such cases the words should be considered as of two syllables; for it is impossible, in continued speaking, to utter a complete consonant sound at the end of a word, without emitting a vowel sound. 7. That the Hebrew, which is to be considered as a representative of all the cognate eastern languages, never sounded a consonant without a vowel, may be inferred from this circumstance, that those who invented denotements of vowel sounds, while at least the leading features of the pronunciation remained, thought it necessary to add, or suppose understood, a vowel sound after every consonant.

Respecting the Chinese language, our readers will find many particulars in the article before referred to, *viz.* WRITING, *origin of, alphabetical.*

LANIARD, a short piece of rope or line fastened to several machines in a ship, and serving to secure them in a particular place, or to manage them more conveniently; such are the laniards of the gun-ports, the laniard of the buoy, the laniard of the cat-hook, &c.

The principal laniards used in a ship are those employed to extend the shrouds and stays of the masts by their communication with the dead-eyes and hearts, so as to form a sort of mechanical power, resembling that of a tackle.

LANIUS, the *shrike,* in natural history, a genus of birds of the order Picæ. Generic character: bill straightish, with a tooth or notch near the end of the upper mandible; the tongue jagged at the end; outer toe connected with the middle one so far as the first joint. These birds are ranked by Gmelin with the Accipitres, and have been by others placed in the order Passeres; according to Kramer, Scopoli, and Pennant, however, they most appropriately attach to the Picæ. There are, according to Gmelin, fifty-six species. Latham enumerates forty-nine, of which it will be sufficient to notice the following: L. excubitor, the great shrike, is about the length of ten inches, and found in France in great numbers, but rare in England. It subsists on insects and small birds, seizing the last by the throat and strangling them, and then fixing them (as some naturalists have reported) on a thorn, from which it tears them piece-meal and devours them. To decoy them within its reach, it imitates the songs of many birds, which approach, delighted by the sounds, and unsuspicious of the danger. It is a favourite bird with husbandmen, as it is considered by them a mortal enemy to rats, mice, and other species of vermin. It, however, prefers mountainous and secluded situations to the neighbourhood of mankind. It appears contented in confinement, but is completely silent in it with respect to any song. It may often be perceived to hang its food, before devouring it, on the wires of its cage. See Aves, Plate VIII. fig. 4.

L. colluris, or the red-backed shrike, is much more frequently to be met with in England than the last species. It is particularly fond of grass hoppers and beetles, which, as indeed various other articles of its food, it will stick upon a thorn. The manners of this species and the last are, in fact, extremely similar. It imitates the sounds of other birds, to decoy them to destruction. During incubation, the female discovers herself to any person approaching her nest by violent clamours of alarm. In St. Domingo there is a species of these birds daring in the extreme, particularly in the breeding season, in which they will attack every bird that approaches, without hesitation or distinction. In Carolina there is another species equally intrepid and ferocious. They will assail the crow, and even the eagle, if it attempts to intrude upon their

premises, collecting in considerable numbers against the aggressor, and seldom failing to make him repent of his temerity. These are denominated the tyrants of Carolina; L. tyrannus, Lin.

LANTANA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx obscurely, four-toothed; stigma hook, refracted; drupe with a two-celled nucleus. There are nineteen species. These are mostly shrubs, very few being herbaceous. The branches are quadrangular; the leaves opposite, in pairs, except in a few cases, where there are three or four together, ovate and wrinkled; flowers aggregate, in axillary and peduncled heads, each flower bracted.

LANTERLOO, or Loo, a game at cards, played several ways, whereof we shall only mention two.

The first way is this: lift for dealing, and the best put carries it: as many may play as the cards will permit; five being dealt to each, and then turning up trump. Now, if three, four, five, or six play, they may lay out the threes, fours, fives, sixes, and sevens, to the intent they may not be quickly looed; or if they would have the loos come fast about, then they are to play with the whole pack.

Having dealt, set up five scores, or chalks. Then ask every one, beginning with the eldest in hand, whether they will play, or pass from the benefit of the game: and here it is to be observed, that the cards have the same values as in honours. You may play upon every card what sum you please, from a penny to a pound; and if looed, that is, win never a trick, you must lay down to the stock so much for your five cards, as you played upon every one of them. Every deal rub off a score, and for every trick you win set up a score, till the first scores are out; then counting your scores, or the numbers of the tricks you have won, you are to take from the stock in proportion to the value. A flush, or five cards of a suit, loos all the other hands, and sweeps the boards; and if there be two flushes, the eldest in hand hath the advantage: the knave of clubs, called paam, has this privilege, that he makes a suit with any other cards, and saves the person who has him from being looed.

The other way is this: the dealer lays down so much for every card as the company please to play for; and the cards being dealt, all must play; if any be looed, they must each lay down so much as the cards are valued at, for their loo; and if the person next dealing be looed, he must lay down double the said sum, *viz.* one for dealing, and the other for his loo. In case of a loo, the gamesters are asked whether they will play or not, beginning at the eldest hand; but if there is no loo, they must all play as at first; and this necessity they justly call force.

If there be never a loo, the money may be divided by the gamesters, according to the number of their tricks, or left till one be looed, as they shall judge proper.

LANTERN, *magic*, an optic machine, whereby little painted images are represented so much magnified as to be accounted the effect of magic by the ignorant. See OPTICS.

The contrivance is briefly this: A B C D (Plate VIII. Miscel. fig. 1.) is a tin lantern, from whose side there proceeds a square tube *b n k l m c*, consisting of two parts; the outermost of which, *n k l m*, slides over the other, so as that the whole tube may be lengthened or shortened by that means. In the end of the arm, *n k l m*, is fixed a convex glass, *k l*; about *d e* there is a contrivance for admitting and placing an object, *d e*, painted in dilute and transparent colours, on a plane thin glass; which object is there to be placed inverted. This is usually some ludicrous or frightful representation, the more to divert the spectators; *b h c* is a deep convex glass, placed in the other end of the prominent tube, the only use of which is to cast the light of the flame, *a*, strongly on the picture, *d e*, painted on the plane thin glass. Hence, if the object, *d e*, be placed further from the glass, *k l*, than its focus, it is manifest that the distinct image of the object will be projected by the glass, *k l*, on the opposite white wall, F H, at *f g*; and that in an erect posture: so that, in effect, this appearance of the magic lantern is the same with that of the camera obscura, or darkened room; since here the chamber, E F G H, is supposed quite dark, excepting the light in the lantern A B C D. And here we may observe, that if the tube, *b n k l m c*, be contracted, and thereby the glass, *k l*, brought nearer the object, *d e*, the representation, *f g*, will be projected so much the larger, and so much the more distant from the glass *k l*; so that the smallest picture at *d e* may be projected at *f g* in any greater proportion required, within due limits: whence it is, that this lantern got the name of *lanterna megalographica.* On the other hand, protracting the tube will diminish the object.

Instead of the convex glass to heighten the light, some prefer a concave specu-

lum, its focus being nearer than that of a lens; and in this focus they place the candle.

LAPIDARY *style*, denotes the style proper for monumental or other inscriptions; being a sort of medium between prose and verse. The jejune and brilliant are here equally to be avoided. Cicero has prescribed the rules of this style. "Accedat, oportet oratio varia, vehemens, plena spiritûs. Ominum sententiarum gravitate, omnium verborum ponderibus, est utendum." The lapidary style, which was lost with the ancient monuments, is now used in various ways, at the beginning of books; and even epistles dedicatory are composed in it, whereof we have no example among the ancients.

LAPIS *lazuli*. See LAZURSTEIN.

LAPIS *infernalis*. See LUNAR *caustic*.

LAPLISIA, in natural history, *sea-hare*, a genus of the Vermes Mollusca class and order. Body creeping, covered with reflected membranes, with a membranaceous shield on the back, covering the lungs; aperture placed on the right side, vent above the extremity of the back; four feelers, resembling ears. There are two species, *viz.* L. depilans; body pale-lead-colour, immaculate, it inhabits the European seas; from two to five inches long; is extremely nauseous and fetid, and is said to cause the hair to fall off from the hands of those who touch it.

L. fasciata, black; the edges of the membranaceous coverings, and of the feelers scarlet; it inhabits the shores of Barbary, among rocks; when touched it discharges a black and red sanies, which, however, is neither fetid nor depilatory like the last. It is frequently to be met with off Anglesea.

LAPPAGO, in botany, a genus of the Triandria Digynia class and order. Natural order of Gramina. There is but one species.

LAPSANA, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ, Semiflosculosi. Cichoraceæ, Jussieu. Essential character: calyx calycled; each of the inner scales channelled; receptacle naked. There are five species, of which L. communis, common nipplewort, is very abundant all over Europe in hedges, shady, and waste places, and cultivated ground; flowering in the summer months. Nature has amply supplied the want of that down to the seed with which most of this class are furnished, by the great abundance which every plant produces.

LAPSED *legacy*, is, where the legatee dies before the testator, or where a legacy is given upon a future contingency, and the legatee dies before the contingency happens. As if a legacy is given to a person when he attains the age of twenty-one years, and the legatee dies before that age; in this case, the legacy is a lost or lapsed legacy, and shall sink into the *residuum* of the personal estate.

LARCENY is the felonious and fraudulent taking away of the personal goods of another, against his will, with intent to steal them. If the goods are above the value of 12*d.*, it is called grand larceny; if of that value, or under, it is petit larceny; which two species are distinguished in their punishment, but not otherwise. The mind, or intention, of the act alone makes the taking of another's goods felony, or a bare trespass only; but as the variety of circumstances is so great, and the complications thereof are so mingled, it is impossible to prescribe all the circumstances evidencing a felonious intent, or the contrary.

As all felony includes trespass, every indictment must have the words feloniously took, as well as carried away; whence it follows, that if the party be guilty of no trespass in taking the goods, he cannot be guilty of felony in carrying them away. With respect to what shall be considered a sufficient carrying away, to constitute the offence of larceny, it seems that any, the least removing of the thing taken, from the place where it was before, is sufficient for this purpose, though it be not quite carried off; but there must be a removal from the place, though it is put back again: and where a pack in a waggon was not actually moved away, but only turned up an end, in order to be carried off, it was held no felony.

As grand larceny is a felonious and fraudulent taking of the mere personal goods of another above the value of 12*d.*, so it is petit larceny, where the thing stolen is but of the value of 12*d.*, or under. In the several other particulars above mentioned, petit larceny agrees with grand larceny; but in a petit larceny there can be no accessaries either before or after.

Larceny from the person. If larceny from the person be done privily without one's knowledge, by picking of pockets or otherwise, it is excluded from the benefit of clergy, by 8 Elizabeth, c. 4. provided the thing stolen be above the value of 12*d.*, but if done openly and

avowedly before one's face, it is within the benefit of clergy.

Larceny from the house. By the common law this was not punished otherwise than as a simple larceny, except in the case of burglary, which is a breaking into a house in the night-time, with intent to steal, and punished capitally; but now, by several statutes, stealing in a house is deprived of the benefit of clergy in almost every instance. As, first, in larceny above 12*d.*, in a church or chapel, without violence or breaking the same. Secondly, in a booth or tent, in a fair or market, by day or night, by violence or breaking the same, the owner or some person of his family being therein. Thirdly, by robbing, which implies breaking into, a dwelling-house in the day time, no person being therein. Fourthly, in the same, by day or night, without breaking, any person being therein, and put in fear. Secondly, in larcenies to the value of 5*s.*, committed, first, by breaking any dwelling-house, or out-house, shop, or warehouse, no person being therein in the day time. Secondly, by privately stealing in a shop, warehouse, coach-house, or stable, by day or night, though the same be not broken open, and no person being therein. Lastly, in larcenies to the value of 40*s.*, from a dwelling-house or its out-houses, although the same be not broken, and whether any person be therein or not, unless by apprentices under fifteen against their masters.

Every person who shall be convicted of the feloniously taking away in the daytime any money or goods of the value of 5*s.*, in any dwelling-house or out-house thereunto belonging, and used to and with the same, though no person be therein, shall be guilty of felony, without benefit of clergy. 39 Elizabeth, c. 15.

Receiving stolen goods. Any person who shall buy or receive any stolen goods, knowing them to be stolen; or shall receive, harbour, or conceal any felons or thieves, knowing them to be so, shall be deemed accessary to the felony; and being convicted, on the testimony of one witness, shall suffer death as a felon convict; but he shall be entitled to his clergy. 5 Anne, c. 31. Any person convicted of receiving or buying stolen goods, knowing them to be stolen, may be transported for fourteen years. 4 George I. c. 11. Where the principal felon is found guilty to the value of 10*d.*, that is, of petit larceny only, the receiver, knowing the goods to have been stolen, cannot be transported for fourteen years, and ought not to be put upon his trial. For the acts which make receivers of stolen goods, knowingingly, accessaries to the felony, must be understood to make them accessaries in such cases only, where, by law, an accessary may be; and there can be no accessary to petit larceny.

Every person who shall apprehend any one guilty of breaking open houses in a felonious manner, or of privately and feloniously stealing goods, wares, or merchandizes, of the value of 5*s.*, in any shop, warehouse, coach-house, or stable, though it be not broken open, and though no person be therein to be put in fear, and shall prosecute him to conviction, shall have a certificate without fee, under the hand of the judge, certifying such conviction, and within what parish and place the felony was committed, and also that such felon was discovered and taken, by the person so discovering or apprehending him; and if any dispute arise between several persons so discovering or apprehending, the judge shall appoint the certificate into so many shares, to be divided among the persons concerned, as to him shall seem just and reasonable. This certificate is commonly called a Tyburn ticket, and exempts the person from all parish and ward offices in the parish where the robbery was committed.

With respect to the offence of larceny, it is difficult in so short a compass to define the particular distinctions which have been made; but it may be useful to mention some general particulars.

To constitute a larceny, there must be a taking the goods without the consent of the owner; so that a fair loan, borrowing, or receipt of goods upon trust, which are afterwards converted, with intention to steal, to the use of the borrower, does not constitute a larceny or theft; but there are cases in which servants who have goods delivered to them, also apprentices, bankers' clerks, and others, may be guilty of larceny; and there are others, where the delivery of goods having been obtained by fraud, for the purpose of stealing them, a theft is held to be committed. A man may also be guilty of this offence, though the goods are his own, as where he steals goods from a pawnbroker, or other person who has a property in them for a particular purpose and limited time, with intent to charge him with the loss.

The felonious taking must also be from the possession of the owner; that is, either constructively or actually his pos-

session; which may be where the thief has the actual possession, as a watch delivered for the purpose of being pawned. And the goods must be personal chattels, not such as savour of the reality, such as standing corn; but corn cut, or trees felled, are personal chattels, and may be the subject of larceny; and there are many statutes which make stealing certain articles, as lead, iron, and other things specified, affixed to the house or freehold, larceny. Bonds and bills were not such property as could be said to be stolen at common law, but they are made so by the statute law. And though it cannot be committed of vile animals which are wild by nature, yet the stealing of domesticated and tame animals is larceny, such as dogs, horses, fowls, and even hawks.

LARIX, in botany, the *larch-tree*, a species of Pinus. See the article PINUS.

LARK. See ALAUDA.

LARVA, in natural history. The larva state of insects, in general, denotes caterpillars of all kinds. The caterpillar state is that through which every butterfly must pass before it arrives at its perfection and beauty.

The change from caterpillar to butterfly was long esteemed a sort of metamorphosis, or real change of one animal into another; but this is by no means the case. The insects of the genus ichneumon contributed much to establish and perpetuate such absurd notions, in former naturalists. These insects are parasites, and deposit their eggs in the bodies of the larvæ of butterflies, moths, &c. The young proceeding from those eggs nourish themselves at the expense of the caterpillar, by feeding upon those parts which are not immediately vital. The caterpillar is at length killed, and the perfect ichneumon comes forth, much to the surprise of the observer, who, anticipating a different result, viewed it as an instance of equivocal generation. But the more accurate observations of modern naturalists have shown, that the egg of a butterfly produces a butterfly, with all the lineaments of its parent; only these are not disclosed at first, but for the greater part of the animal's life they are covered with a sort of case or muscular coat, in which are legs for walking: these only suit it in this state, but its mouth takes in nourishment, which is conveyed to the included animal; and after a proper time this covering is thrown off, and the butterfly, which all the while might be discovered in it by an accurate observer, with the help of a microscope, appears in its proper form. The care of all the butterfly tribe to lodge their eggs in safety is surprising. Those whose eggs are to be hatched in a few weeks, and who are to live in the caterpillar state during part of the remaining summer, always lay them on the leaves of such plants as will afford a proper nourishment; but, on the contrary, those whose eggs are to remain unhatched till the following spring, always lay them on the branches of trees and shrubs, and usually are careful to select such places as are least exposed to the rigour of the ensuing season, and frequently cover them from it in an artful manner. Some make a general coat of a hairy matter over them, taking the hairs from their own bodies for that purpose; others hide themselves in hollow places, in trees, and in other sheltered cells, and there live in a kind of torpid state during the whole winter, that they may deposit their eggs in the succeeding springs at a time when there will be no severities of weather for them to combat. The day-butterflies only do this, and of these but a very few species: but the night ones, or phalenæ, all, without exception, lay their eggs as soon as they have been in copulation with the male, and die immediately afterwards.

Nothing is more surprising in insects than their industry; and in this the caterpillars yield to no kind, not to mention their silk, the spinning of which is one great proof of it. The sheaths and cases which some of these insects build for passing their transformations in, are by some made with their own hair, mixed with pieces of bark, leaves, and other parts of trees, with paper, and other materials; and the structure of these is well worthy our attention. Yet there are others, whose workmanship in this article far exceeds these. There is one which builds in wood, and is able to give its case a hardness greater than that of the wood itself in its natural state. This is the strange horned caterpillar of the willow, which is one of those that eat their exuviæ. This creature has extremely sharp teeth, and with these it cuts the wood into a number of small fragments; these fragments it afterwards unites together into a case, of what shape it pleases, by means of a peculiar silk, which is no other than a tough and viscous juice, which hardens as it dries, and is a strong and firm cement. The solidity of the case being thus provided for, we are to consider, that the caterpillar inclosed

in it is to become a butterfly; and the wonder is, in what manner a creature of this helpless kind, which has neither legs to dig, nor teeth to gnaw with, is to make its way out of so firm and strong a lodgment as this in which it is hatched. The butterfly, as soon as hatched, discharges a liquor which softens the viscous matter that holds the case together; and so its several fragments falling to pieces, the way lies open. Reaumur judged, from the effects, that this liquor must be of a singular nature, and very different from the generality of animal fluids; and in dissecting this creature in the caterpillar state, there will always be found near the mouth, and under the œsophagus, a bladder of the size of a small pea, full of a limpid liquor, of a very quick and penetrating smell, and which, upon trial, proves to be a very powerful acid; and among other properties, which it has in common with other acids, it sensibly softens the glue of the case, on a common application. It is evident that this liquor, besides its use to the caterpillar, remains with it in the chrysalis state, and is what gives it a power of dissolving the structure of the case, and making its way through in a proper manner at the necessary time.

Boerhaave adopted the opinion that there are no true acids in animals, except in the stomach or intestines; but this familiar instance proves the contrary. Another very curious and mysterious artifice is that by which some species of caterpillars, when the time of their changing into the chrysalis state is coming on, make themselves lodgments in the leaves of the trees, by rolling them up in such a manner as to make themselves a sort of hollow cylindric case, proportioned to the thickness of their body, well defended against the injuries of the air, and carefully secured for their state of tranquillity. Besides these caterpillars, which in this manner roll up the leaves of plants, there are other species which only bend them once, and others, which, by means of thin threads, connect many leaves together to make them a case. All this is a very surprising work, but much inferior to this method of rolling.

The different species of caterpillars have different inclinations, not only in their spinning and their choice of food, but even in their manners and behaviour one to another. Some never part company from the time of their being hatched to their last change, but live and feed together, and undergo together their change into the chrysalis state. Others separate one from another as soon as able to crawl about, and each seeks its fortune single; and there are others which regularly live to a certain time of their lives in community, and then separate, each to shift for itself, and never to meet again in that state. See ENTOMOLOGY, INSECTS, &c.

LARUS, the *gull*, in natural history, a genus of birds of the order Anseres. Generic character: bill strong, straight, sharp edged, bending down somewhat at the tip; lower mandible exhibiting an angular prominence; nostrils in the middle of the bill; body light; wings long; legs small, and naked above the knee; back toe small. They inhabit principally the northern climates, subsisting on carrion, and on fishes. They are reported, when greatly alarmed, almost universally to throw up from their stomach the food they have recently swallowed. Gmelin reckons fifteen species, and Latham nineteen. L. marinus, is twenty-nine inches in length, and of the weight of five pounds. It is found in various parts of England, and on most of the northern coasts of Europe. It breeds in the most elevated cliffs, laying its eggs on heaps of dung deposited by various birds. It feeds principally on fishes, but sometimes attacks birds, and is said to bear a particular enmity to the eider-duck. See Aves, Plate IX. fig. 2.

L. fuscus, or the herring gull, is somewhat less than the former, frequents the same situations, and subsists, like that, chiefly upon fish. In the herring season it is seen watching the nets of the fishermen, and is daring enough frequently to seize its prey from the boats and nets.

L. canus, is sixteen inches long, and about a pound in weight. It breeds on the rocks and cliffs on the British coasts; and on the banks of the Thames, near its union with the sea, may be seen in immense numbers, picking up the worms and small fishes deposited by the tide. It will also follow the course of the plough over the fields, and delights in the insects and worms which are thrown up by it. The cockchafer, in its larva state, is a particular favourite with this bird. See Aves, Plate IX. fig. 1.

L. ridibundus, the black-cap, or pewit gull, breeds in the fens of Lincolnshire and Cambridgeshire, England; and, after the season of breeding is over, returns to the coasts. In some parts of Syria these birds are so familiar as to approach on being called, and to catch pieces of bread

in the air as they are thrown up from the hands of the women. The old birds of this species are both rank and tough, but the young are eaten by many persons, and were formerly much admired for the table, taken so young as to be unable to fly. The particular islets in the fenny wastes of Lincolnshire, which used to be preferred by these birds for breeding, were every year in winter cleared of weeds, rushes, and other impediments, in preparation for their return in large flocks to breed in the spring, and when the young had attained the precise growth, several men were employed with long staves to hurry them into nets spread for their reception. This process constituted a favourite diversion, and the rich and fashionable assembled to be spectators of it from a considerable distance. The birds were sold at the rate of five shillings per dozen, and in the details of royal and noble feasts, will be found to have constituted an article of high and almost indispensable importance.

L. catarractus, or the brown gull, weighs about three pounds. It is more frequent in the cold than in the warmer latitudes, and is perhaps the most daring and fierce of all the species. In the Faro islands, lambs are stated to be often torn to pieces by it, and carried to its nest. On the island of Foula, however, it is said to be highly valued on account of its enmity to the eagle, which it attacks, and follows with the most animated hostility, in this instance becoming the means of security to flocks. It frequently makes prey of the smaller gulls and of other birds, and is often observed to watch the movements of birds on the water, and as they are bearing off their prey in triumph and imagined security, to pounce upon them with amazing rapidity, obliging them to drop their victims, which in the same instant are intercepted by this rapacious intruder. Even the albatross, when on the wing, though so much larger than this bird, is by no means a match for it in strength and courage, and finds its effectual resource only in alighting upon the water, which it does with all possible rapidity, when the skua immediately ceases to annoy it. During the season of incubation, the skua gull will attack every creature approaching its habitation, not excepting the human species, several of whom have been assailed by it in company, with an energy and fury truly formidable. Its feathers are in high estimation, and thought by many equal to those of the goose. It is in many places killed merely for these.

L. tridactylus, or the tarrock, breeds in Scotland, and is found so far north as Spitzbergen. It is an attendant on the progress of whales and other large fishes, which drive the smaller inhabitants of the ocean into creeks and shallows, where the tarrocks suddenly dart on them, ensuring always an easy and full repast. They are very clamorous, swim and fly well, are often seen on detached pieces of ice, are used by the inhabitants of Greenland for food, their eggs being highly valued for the same purpose, while their skins are converted into materials for caps and garments. For the black-toed gull, see Aves, Plate IX. fig. 3.

LARYNX, the thick upper part of the aspera arteria, or wind-pipe. See ANATOMY.

LASERPITIUM, in botany, *laserwort*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ or Umbelliferæ. Essential character: petals bent in, emarginate, spreading; fruit oblong, with eight membranaceous angles. There are fifteen species, natives of the South of Europe.

LASIOSTOMA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Apocineæ, Jussieu. Essential character: calyx very short, five petalled, with two acute scales; corolla funnel form, four-cleft; capsule orbiculate, one-celled, two-seeded. There is only one species, *viz.* L. rouhamon; this is a shrub, seven or eight feet in height, with a greyish irregular bark, and a whitish wood; branches and branchlets opposite, covered with a russet down, spreading over the neighbouring trees. The branchlets are knobbed, and at each joint have a pair of leaves, ending in a point; they are of a pale green colour, on short petioles; flowers in small axillary corymbs, on a small peduncle, which has two scales at the base; corolla white; capsule yellow; this shrub is called by the Caribs rouhahamon; it is in flower and fruit during the months of October and November; it is found on the banks of the river Sinemari, in Guiana, forty leagues from its mouth.

LAST, in general, signifies the burden or load of a ship.

It signifies, also, a certain number of fish, corn, wool, leather, &c. A last of cod-fish, white herrings, meal, and ashes

for soap, is twelve barrels; of corn or rape-seed, ten quarters; of gun-powder, twenty-four barrels; of red herrings, twenty cades; of hides, twelve dozen; of leather, twenty dickers; of pitch and tar, fourteen barrels; of wool, twelve sacks; of stock-fish, one thousand; of flax or feathers, 1700*lb.*

LATH, in building, a long, thin, and narrow slip of wood, nailed to the rafters of a roof or ceiling, in order to sustain the covering. These are distinguished into three kinds, according to the different kinds of wood of which they are made, *viz.* heart of oak, sap-laths, and deal-laths; of which the two last are used for ceilings and partitions, and the first for tiling only. Laths are also distinguished, according to their length, into five feet, four feet, and three feet laths, though the statute allows but of two lengths, those of five, and those of three feet, each of which ought to be an inch and a half in breadth, and half an inch in thickness, but they are commonly less.

LATHS, *of cleaving.* The lath-cleavers having cut their timbers into lengths, they cleave each piece with wedges, into eight, twelve, or sixteen, according to the size of their timber; these pieces are called bolts; this is done by the felt-grain, which is that grain which is seen to run round in rings at the end of a piece of a tree. Thus they are cut out for the breadth of the laths, and this work is called felting. Afterwards they cleave the laths into their proper thicknesses with their chit, by the quarter-grain, which is that which runs in a straight line towards the pith. See GRAIN.

LATHE, in turning, is an engine used in turning wood, ivory, and other materials.

The lathe we are about to describe is made of iron, in the best manner. See Plate LATHE. Fig. 1, is an elevation of the whole machine frontwise; fig. 2, an elevation sideways; fig. 3, an elevation of the lathe only on a larger scale; in fig. 4, are two elevations of an apparatus to be attached to the lathe for drilling holes; fig. 5, is an elevation of the rest; and fig. 6, a face elevation of one of the puppets.

The frame of the lathe is of wood, and consists of two ground cells, *a b*, two uprights, *d d*, morticed into them, and cross pieces, *e f*, at top, connecting them together; upon the uppermost of these pieces the bench sustaining the lathe is fixed; *g* is another bench, supported by iron brackets, to receive a vice or other tools, at the option of the workmen; between the two uprights, *d d*, the axis of the great foot wheel turns; it is pointed at the ends and turns in small conical holes in pieces of hard steel let into the uprights, *d d*; one of these holes is in the end of a screw, by turning which, the axis can be tightened up so as to turn very freely without any shake; the axis is made of wrought iron, and the points at the end are of hard steel welded together; it is bent in the middle to form a crank; and *h* is the connecting rod, by which it is moved from a treadle, *i*; the treadle is a piece of board, *i*, seen endways, in fig. 2, screwed to an axle, *k*, at one end, on which it turns, and at the other end is broader, to receive the workman's foot; in the middle a staple is fixed, and the connecting rod, *h*, hooked to it; A is the great wheel of cast iron, and of considerable weight in the rim, wedged fast on the axis, and turns round with it; it is by the momentum of this wheel that it continues to turn, while the crank and treadle are rising, and consequently when the workman exerts no power upon them. When the crank has passed the vertical position, and begins to descend, he presses his foot upon the treadle, to give the wheel a sufficient impetus, to continue its motion until it arrives at the same position again.

We now come to describe the upper part of the machine, or lathe, the wheel and treadle being only the first mover, it is shewn on a larger scale in fig. 3, and it is to this figure we shall refer in describing it; B B is a strong triangular iron bar, firmly supported by its ends, on two short pillars screwed at their lower ends to the bench; this bar is perfectly straight and the sides flat; D E are two iron standards, called puppets, fitted upon the triangular bar, D, and fixed at any place by screws; they are both alike, and one of them is shewn endways in fig. 6; it has an opening made in it at the bottom, the inside of which is filed extremely true, to fit upon the upper angle of the bar B B, through each of the branches, formed by the opening in the bottom mortices, are cut, as is well seen in fig. 3; these receive the end of a short piece of iron, *m*, having a screw tapped into it; it is by screwing this screw tight up against the underside of the bar, that the puppet is fastened upon it; a small piece of iron plate is put between the end of the screw and the underside of the bar,

to defend it from bruises by the latter; the upper end of the puppets are perforated with cylindrical holes, to receive truly turned pins, *n n*, and which are fixed at any place by screws, *o o*; these holes must be exactly in a line with each other, when the puppets are set at any place upon the bar, and it is to accomplish this, that too much care cannot be taken in forming the bar perfectly straight and true in the first instance, and of sufficient strength to preserve its figure. F is another puppet, fixed on the bar, in the same manner as D and E: it has a conical hole through its upper end, whose centre is exactly in the same line with the holes through the other two puppets D and E; this conical hole is the socket for the mandrill, G, to turn in, being conical at that part, and fitting the socket with the greatest accuracy; the other end is pointed, and turns in a hole made in the pin, *n*, of the puppet, D, and which, besides the screw, *o*, has another at its end tapped into a cock, screwed to the puppet, to keep it up to its work; the mandrill has a pulley fixed on it, with three grooves of different sizes, to receive a band of catgut which goes over it, and round the great iron wheel, A A; it is by this that the mandrill is turned. I is the rest, composed of three principal pieces, shown separate in fig. 5, one of these pieces, *r*, is filed to an angle withinside, and furnished with a screw similar to the puppets, whereby it can be fastened to the bar; on each side of this, pieces of iron, *s s*, are laid on the bar, and are fastened together by two short bars, *t t*, to which they are both screwed, the main piece, *r*, being cut away to make room for them. L is the bottom part of the rest, supported on the two pieces, *s s*, it has a dove-tailed groove along the underside; a button, with a head like a screw, is fastened to the top of the main piece, *r*, and is received into the groove; when the screw of the piece, *r*, is turned, it draws the button down towards the bar, and as its head takes its bearing on the inside of the groove, it must hold the piece L fast down upon the pieces, *s s*; when the screw is loosened, the whole rest can be moved along the bar B, the piece L can be slid backwards and forwards upon the pieces, *s s*, or it can be turned round upon the button of the piece, *r*, as a centre, at the convenience of the workmen; and all these motions are firmly clamped by the screw beneath the bar. The piece L has at one end a short iron tube fixed to it, in this an iron pin is fitted, to hold at its upper end the cross bar, V, on which the tool is laid, a screw is fixed in the tube, and a nut upon it presses a piece of iron, *w*, upon the ends of two short pins going through the tube, the other ends take against the large iron pin of the rest, V; when the nut is unscrewed, the rest can be set higher or lower, or turned round obliquely, and fixed by turning the nut; the bar, *v*, of the rest, is fixed on by a screw, so that it can be easily changed for another when worn, or for different work there should be two or three of different sizes with the lathe. The mandrill, G, of the lathe should be of iron, and at the part where it turns in the collar, F, it should have a piece of good steel welded round it, and turned very true in a lathe, and also the point at the end should be of steel; a small hole is drilled down from the top of the puppet, F, into the collar, to supply it occasionally with oil. The end of the mandrill, beyond the collar, is formed into a male screw, whereon to fix the work to be turned. The manner of holding the work varies in almost every instance, and is explained under the article TURNING; in general, it is held in pieces of wood called cheeks, screwed to the mandrill, they are turned hollow like a dish, and the work is driven into the cavity, as shown in fig. 1.

LATHRÆA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx four-cleft; gland depressed at the base of the suture of the germ; capsule one-celled. There are four species, of which L. squamaria, great tooth-wort, has a headed root, branched and surrounded with white succulent scales; it is parasitical, and generally attached to the roots of elms, hasels, or some other trees, in a shady situation; or, it has usually a naked stem; flowers in a spike from one side of the stem in a double row; calyx hairy; segments equal; corolla pale purple, or flesh-coloured, except the lower lips, which is white. Native of most parts of Europe.

LATHYRUS, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx two, upper segments shorter; style flat, villose above, broader at the end. There are twenty-three species, among which is the L. odoratus, sweet lathyrus, or sweet pea, as it is commonly called, is an annual plant, about three feet in height, attaching itself to the nearest

plant, by means of its long claspers or tendrils, the flower stalks come out at the joints, which are about six inches long, sustaining two large flowers, possessing a strong odour; these are succeeded by oblong hairy pods, having four or five roundish seeds in each. There are many varieties, according to Linnæus; the common dark sort is a native of Sicily, and the painted lady of Ceylon.

LATITAT, in law, a writ, which in personal actions is the commencement of a suit in the King's Bench, where the party is to be arrested in any other county than Middlesex.

LATITUDE, the distance of a place from the equator, or an arc of the meridian intercepted between the zenith of the place and the equator. Hence latitude is either northern or southern, according as the place, whose latitude is spoken of, is on this or that side of the equator. Thus London is said to be in fifty-one degrees thirty-two minutes north latitude. Circles parallel to the equator, are called parallels of latitude, because they shew the latitudes of places by their intersection with the meridian. If through the poles of the world we conceive innumerable great circles drawn, these are called secondaries of the equator, and by their help, the position of every point, either on earth or in the heavens, with regard to the equinoctial; that is, the latitude of any point is determined. One of the secondaries, passing through any place on the earth's surface, is called the meridian of that place, and on it the latitude of that place is measured. The latitude of a place, and the elevation of the pole of that place above the horizon, are terms used indifferently for each other, because the latitude and elevation of the pole are always equal. The knowledge of the latitude of a place is of the utmost consequence in navigation; and the methods of determining it, both at sea and land, are generally the same. As the altitude of the pole is always equal to the latitude, the latitude is consequently best found by observing the pole's height; but as the pole is only a mathematical point, and no ways to be observed by our senses, its height cannot be determined in the same manner as that of the sun and stars, &c.; for which reason another manner has been contrived. A meridian line is first drawn, on which is placed a quadrant, so that its plane may be in the plane of the meridian; then some star near the pole is taken; for example, the pole star, (which never sets) and observation is made of both its greatest and least altitude. The latitude may also be found by having the sun or a star's declination and meridian altitude, taken with a quadrant or astrolabe. The method is this: observe the meridian and distance of the sun from the vertex or zenith, which is always the complement of his meridian altitude; correct for the dip of the horizon, refraction, and add to this the sun's declination, when the sun and the place are on the same side of the equator; and subtract the declination when they are of different sides; the sum, in the former case, and the difference, in the latter, will be the latitude required. But when the declination of the sun is greater than the latitude of the place, which is known from the sun's being nearer to the elevated pole than the vertex of the place is, as it frequently happens in the torrid zone, then the difference between the sun's declination and his zenith distance, is the latitude of the place. If the sun or star have no declination, but move in the equinoctial that day, then the elevation of the equator will be equal to his meridian altitude, and consequently his meridian altitude is the complement of the latitude to ninety.

LATITUDE, in astronomy, the distance of a star or planet from the ecliptic, in degrees, minutes, and seconds, measured on a circle of latitude drawn through that star or planet, being either north or south, as the object is situated either on the north or south side of the ecliptic. The ecliptic being drawn on the common celestial globes, we may see what constellations it passes through: there are usually six circles of latitude, which, by their mutual intersections, show the poles of the ecliptic, as well as divide it into twelve equal parts, answerable to the number of months in a year.

LATTEN, denotes iron plates tinned over, of which tea-canisters are made. Plates of iron being prepared of a proper thinness, are smoothed by rusting them in an acid liquor, as common water made eager with rye: with this liquor they fill certain troughs, and then put in the plates, which they turn once or twice a day, that they may be equally rusted over; after this they are taken out, and well scowered with sand, and, to prevent their rusting again, are immediately plunged into pure water, in which they are to be left till the instant they are to be tinned or blanched, the manner of doing which is this: they flux the tin in a large iron crucible, which has the figure

of an oblong pyramid with four faces, of which two opposite ones are less than the two others. The crucible is heated only from below, its upper part being luted with the furnace all round. The crucible is always deeper than the plates, which are to be tinned, are long; they always put them in downright, and the tin ought to swim over them; to this purpose artificers of different trades prepare plates of different shapes; though M. Reaumur thinks them all exceptionable. But the Germans use no sort of preparation of the iron, to make it receive the tin, more than the keeping it always steeped in water till the time; only when the tin is melted in the crucible, they cover it with a layer of a sort of suet, which is usually two inches thick, and the plate must pass through this before it can come to the melted tin. The first use of this covering is to keep the tin from burning; for if any part should take fire, the suet would soon moisten it, and reduce it to its primitive state again. The blanchers say, this suet is a compounded matter; it is indeed of a black colour, but M. Reaumur supposed that to be only an artifice, to make it a secret, and that it is only coloured with soot or the smoke of a chimney; but he found it true so far, that the common unprepared suet was not sufficient; for after several attempts, there was always something wanting to render the success of the operation certain. This whole secret of blanching, therefore, was found to lie in the preparation of this suet; and this, at length, he discovered to consist only in the first frying and burning it. This simple operation not only gives it the colour, but puts it into a condition to give the iron a disposition to be tinned, which it does surprisingly. The melted tin must also have a certain degree of heat, for if it is not hot enough, it will not stick to the iron; and if it is too hot, it will cover it with too thin a coat, and the plates will have several colours, as red, blue, and purple, and upon the whole will have a cast of yellow. To prevent this, by knowing when the fire has a proper degree of heat, they might try with small pieces of iron; but in general, use teaches them to know the degree, and they put in the iron when the tin is at a different standard of heat, according as they would give it a thicker or a thinner coat. Sometimes also they give the plates a double layer, as they would have them very thickly covered. This they do by dipping them into the tin, when very hot, the first time; and when less hot, the second. The tin which is to give the second coat must be fresh covered with suet, and that with the common suet, not the prepared.

LATUS *rectum*, in conic sections, the same with parameter. See PARAMETER.

LATUS *transversum*, in the hyperbola, that part of the transverse diameter, intercepted between the vertices of the two opposite sections. See HYPERBOLA.

LAVA, the production of Ætna, Vesuvius, Hecla, and other volcanos, is of a greyish colour passing to green: it is spotted externally, and occurs porous, carious, or vesicular. Its lustre is vitreous, more or less glistering. It is moderately hard, brittle, easily frangible, and light. It generally attracts strongly the magnetic needle. It is easily fusible into a black, compact glass. It frequently encloses other fossils, especially crystals of felspar, augite, hornblende, and leucite. See VOLCANIC *formations*.

LAVANDULA, in botany, *lavender*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx ovate, obscurely toothed, supported by a bracte; corolla re-supine; stamina within the tube. There are seven species, of which L. spica, common lavender, has a shrubby stem much branched, frequently five or six feet high, with numerous hoary leaves, the upper ones sessile, the lower petioled; the flowers are produced in terminating spikes from the young shoots, on long peduncles; the spikes are composed of interrupted whorls, in which the flowers are from six to ten, the lower whorls more remote; each flower upright, on a short pedicle; the usual colour of the corolla is blue, sometimes varying with white flowers; the whole plant is covered with a down, composed of forked hairs. It is a native of the south of Europe, and has long been celebrated for its virtues in nervous disorders; the officinal preparations of lavender, are the essential oil, a simple spirit, and a compound tincture.

LAVATERA, in botany, so named from Lavater, a physician at Zurich; a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character; calyx double, outer trifid; arils very many, one-seeded. There are nine species, of which L. arborea lavatera, or mallow-tree, rises in gardens, with a strong, thick stalk, frequently to the height of eight or ten feet; in its wild state, not more than four or five; leaves alternate, cordate, roundish, seven-angled, the angles blunt,

but soft as velvet, shorter than the petioles; flowers mostly in pairs, sometimes three together, on upright peduncles, an inch and half in length; corolla purplish red, spreading, bell-shaped, like that of the common mallow, an inch or more in diameter; petals broader at top than at the base, so that the calyx appears between the claws. The ring or whorl of fruits is seven or eight-capsuled; common receptacle awl-shaped, with a conoid globule at top, and small crescent-shaped lamellæ at the base, and the interstices of the capsules. Native of Italy, the Levant, and Britain.

LAVENIA, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Discoideæ. Essential character: calyx nearly regular, style bifid; down three-awned, glandular at the tip. There are two species, *viz.* L. decumbens, and L. erecta, the former is a native of Jamaica, and the latter of the East-Indies and the Society Isles.

LAUGERIA, in botany, so called from Robert Laugier, professor of chemistry and botany at Vienna; a genus of the Pentandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character; corolla five-cleft; drupe with a five-celled nut. There are three species, natives of America, West Indies, and Santa Cruz.

LAURUS, in botany, *bay-tree,* a genus of the Enneandria Monogynia class and order. Natural order of Holoraceæ. Lauri, Jussieu. Essential character: calyx none; corolla calycine, six-parted; nectary of three two-bristled glands, surrounding the germ; filaments inner, glanduliferous; drupe one-seeded. There are thirty-two species. This genus consists of trees or shrubs; leaves mostly entire, in a few nearly opposite, commonly perennial, as in most trees of the torrid zone. L. nobilis, common sweet-bay, has been celebrated in all ages; with us it appears as a shrub; but in the southern parts of Europe, it grows from twenty to thirty feet in height; it has large evergreen leaves, of a firm texture, with an agreeable smell, and an aromatic, bitterish taste; flowers dioecious, or male and female on different trees, in racemes shorter than the leaves, of an herbaceous colour: corollas four-petalled in the male flowers; stamens from eight to twelve; berry superior, of a dark purple colour, almost black. It is a native of the southern parts of Europe and Asia. L. persea, alligator, or avocado pear, of the West Indies, is about thirty feet in height; the bark is smooth, and of an ash colour; the branches have large, smooth leaves, like those of laurel; the flowers are mostly produced towards the extremities of the branches; the fruit is the size of one of our biggest pears, inclosing a large seed with two lobes. This fruit is held in great esteem in the West Indies; the pulp is of a pretty firm consistence, and has a delicate, rich flavour; it gains upon the palate of most persons, and soon becomes agreeable even to those who cannot like it at first; it is very rich and mild, so that most people make use of some spice or pungent substance to give it a poignancy.

LAW, (*Sax. lag. Lat. lex*, from *lego*, or *legendo*, choosing, or rather *a ligando*, from binding), the rule and bond of men's actions: or it is a rule for the well governing of civil society, to give to every man that which doth belong to him.

Law, in its most general and comprehensive sense, is defined by Blackstone, in the Commentaries, 'a rule of action,' and is applied indiscriminately to all kinds of action, whether animate or inanimate, rational or irrational. And it is that rule of action which is prescribed by some superior, and which the inferior is bound to obey.

Laws, in their more confined sense, and in which it is the business of works of this nature to consider them, denote the rules, not of action in general, but of human action or conduct. And this perhaps (it has been acutely observed) is the only sense in which the word law can be strictly used; for in all cases where it is not applied to human conduct, it may be considered as a metaphor, and in every instance a more appropriate term (as quality or property) may be found. When law is applied to any other object than man, it ceases to contain two of its essential ingredients, disobedience and punishment.

Municipal law, is by the same great commentator defined to be "a rule of civil conduct, prescribed by the supreme power in a state; commanding what is right, and prohibiting what is wrong." The latter clause of this sentence seems to Mr. Christian to be either superfluous or defective. If we attend to the learned judge's exposition, perhaps we may be inclined to use the words "establishing and ascertaining what is right or wrong;" and all cavil or difficulty will vanish.

Every law may be said to consist of several parts; declaratory, whereby the rights to be observed, and the wrong to be eschewed, are clearly defined and laid

down; directory, whereby the subject of a state is instructed and enjoined to observe those rights, and to abstain from the commission of those wrongs; remedial, whereby a method is pointed out to recover a man's private rights or redress his private wrongs; vindicatory, which imposes the sanction, whereby it is signified what evil or penalty shall be incurred by such as commit any public wrongs, and transgress or neglect any duty.

Laws are arbitrary or positive, and natural; the last of which are essentially just and good, and bind every where and in all places where they are observed; arbitrary laws are either concerning such matter as is in itself morally indifferent, in which case both the law and the matter, and subject of it, are likewise indifferent, or concerning the natural law itself, and the regulating thereof; and all arbitrary laws are founded in convenience, and depend upon the authority of the legislative power which appoints and makes them, and are for maintaining public order; those which are natural laws are from God; but those which are arbitrary, are properly human and positive institutions.

The laws of any country began, when there first began to be a state in the land; and we may consider the world as one universal society, and then that law by which nations were governed, is called *jus gentium;* if we consider the world as made up of particular nations, the law which regulates the public order and right of them, is termed *jus publicum*; and that law which determines the private rights of men, is called *jus civile.*

No law can oblige a people without their consent; this consent is either *verbis* or *factis*, *i. e.* it is expressed by writing, or implied by deeds and actions; and where a law is grounded on an implied assent, *rebus et factis*, it is either common law or custom; if it is universal, it is common law; and if particular to this or that place, then it is custom.

The law in this land hath been variable; the Roman laws were in use anciently in Britain, when the Romans had several colonies here, each of which was governed by the Roman laws: afterwards we had the laws called Merchenlage, West Saxonlage, and Danelage; all reduced into a body, and made one by King Edward the Confessor.

At present the laws of England are divided into three parts: 1. The common law, which is the most ancient and general law of the realm, and common to the whole kingdom; being appropriate thereto, and having no dependence upon any foreign law whatsoever.

2 Statutes, or acts of parliament, made and passed by the King, Lords, and Commons, in Parliament; being a reserve for the government to provide against new mischiefs arising through the corruption of the times. And by this the common law is amended where defective, for the suppression of public evils; though where the common law and statute law concur or interfere, the common law shall be preferred.

3. Particular customs. These must be particular, for a general custom is part of the common law of the land.

Blackstone divides the municipal law of England into two kinds, *lex non scripta*, the unwritten or common law; and the *lex scripta*, the written, that is, the statute law.

The *lex non scripta*, or unwritten law, includes not only general customs, or the common law, properly so called; but also the particular customs of certain parts of the kingdom; and likewise those particular laws, that are by custom observed only in certain courts and jurisdictions.

There is another division of our laws, more large and particular; as into the prerogative or crown law, the law and custom of parliament, the common law, the statute law, reasonable customs, the law of arms, war, and chivalry, ecclesiastical or canon law, civil law, in certain courts and cases, forest law, the law of marque and reprisal, the law of merchants, the law and privilege of the stannaries, &c. But this large division may be reduced to the common division; and all is founded on the law of nature and reason, and the revealed law of God, as all other laws ought to be.

The law of nature is that which God, at man's creation, infused into him, for his preservation and direction; and this is *lex æterna*, and may not be changed; and no laws shall be made or kept, that are expressly against the law of God, written in his scripture; as to forbid what he commandeth.

All laws derive their force *a lege naturæ;* and those which do not, are accounted as no laws. No law will make a construction to do wrong; and there are some things which the law favours, and some it dislikes; it favoureth those things that come from the order of nature. Also our law hath much more respect to life, liberty, freehold, inheritance, matters of

record, and of substance; than to chattels, things in the personalty, matters not of record, on circumstances.

Law *of nations*, is a system of rules deducible, by natural reason, from the immutable principles of natural justice, and established by universal consent amongst the civilized inhabitants of the world, in order to decide all disputes, and to insure the observance of justice and good faith, in that intercourse which must frequently occur between them and the individuals belonging to each; or they may depend upon mutual compacts, treaties, leagues, and agreements between the separate, free, and independent communities. In the construction of these principles, there is no judge to resort to, but the general law of nature and of reason, being the only law with which the contracting parties are all equally conversant, and to which they are all equally amenable. Laws have properly their effect only in the country where and for which they have been enacted. However, 1. Those which relate to the state, and to the personal condition of the subjects, are acknowledged in foreign countries. 2. A foreigner, who is plaintiff against a subject, must abide by the decisions of the law of the country in which he pleads. 3. When the validity of an act done in a foreign country is in question, it ought to be decided by the laws of that foreign country. 4. Sometimes the parties agree to the question being determined by particular laws of a foreign country. 5. A foreign law may have been received as a subsidiary law. 6. Foreigners sometimes obtain the privilege of having their disputes with each other settled by the laws of their own country.

LAWSONIA, in botany, so named from Isaac Lawson, M. D. a genus of the Octandria Monogynia class and order. Natural order of Salicariæ, Jussieu. Essential character: calyx four-cleft; petals four; stamens in four pairs; capsule four-celled, many-seeded. There are four species; natives of warm countries.

LAXMANNIA, in botany, so called from Ericus Laxman, a Swede, a genus of the Hexandria Monogynia class and order. Essential character: calyx one-leafed, four-toothed, inferior; corolla four-petalled; berry four-celled; seeds solitary.

LAYERS, in gardening, are tender shoots, or twigs of trees, laid or buried in the ground; till, having struck root, they are separated from the parent tree, and become distinct plants.

LAZULITE, in mineralogy, is of a deep smalt blue: it occurs disseminated in fine grains, or masses of the size of a hazel nut. The latter often present the appearance of short tetrahedral prisms. Its fracture is uneven, with a glimmering lustre. It is brittle, and easily frangible: at a red heat it loses its colour, and becomes grey. Without addition it is infusible before the blow-pipe, but with borax it runs into a clear yellow glass. It has been analyzed by Klaproth, and is found to contain silex, alumina, and oxide of iron.

LAZURSTEIN, in mineralogy, called also *azure-stone*, a species of the flint genus, is of a perfect azure blue colour, in some varieties it passes into sky blue: it is found massive, disseminated, and in rolled pieces: hard, brittle, and not heavy: specific gravity is from 2.7 to 2.95. It melts into a white enamel before the blow-pipe. When previously calcined and powdered, it forms a jelly with acids: it is composed of

Silica	46.0
Alumina	14.5
Carbonate of lime	28.0
Sulphate of lime	6.5
Oxide of iron	3.0
Water	2.0
	100.0

It has been found in Persia, Bucharia, China, Great Tartary, and Siberia: it is also obtained in considerable quantities in the island of Hainan, in the Chinese sea, from whence it is sent to Canton, where it is employed in painting. It has likewise been met with in South America; and in Europe among the ruins at Rome. It is used in various articles of ornamental dress, and in Mosaic and Florentine work, and is highly valued on account of the fine blue colour which it yields.

LEAD, is a white metal, of a considerably blue tinge, very soft and flexible, not very tenacious, and consequently incapable of being drawn into fine wire, though it is easily extended into thin plates under the hammer. Its weight is very considerable, being rather greater than that of silver. Long before ignition, namely, at about the 540th degree of Fahrenheit's thermometer, it melts; and then begins

to be oxyded, if respirable air be present. In a strong heat it boils, and emits fumes; during which time, if exposed to the air, its oxydation proceeds with considerable rapidity. If melted lead be poured into a box previously rubbed with chalk, to prevent its action on the wood, and be continually agitated, it will concrete into separate grains, of considerable use in various mechanical operations, particularly that of weighing. Lead is brittle at the time of congelation. In this state it may be broken to pieces with a hammer, and the crystallization of its internal parts will exhibit an arrangement in parallel lines.

This metal, during the progress of heat, first becomes converted into a dusky powder, which by a continuation of the heat becomes white, yellow, and afterwards of a bright red, inclining to orange colour, called minium, or red lead. The process requires considerable management with regard to the heat and access of air, in the making of red lead. Many days are required for this purpose. If the heat be too great or rapid, the lead becomes converted into a flaky substance, called litharge; and a still greater heat converts it into a clear, transparent, yellow glass, which powerfully dissolves and corrodes metallic oxides or earths; and on this account it usually finds its way through the crucibles in a short time. It acts more difficultly on argillaceous than on siliceous earths; whence it is found that vessels made of clay mixed with broken pottery are preferable to those that are composed of clay and sand. The oxide of lead is a principal ingredient in most of the modern fine white glasses. It is more particularly calculated to form the dense glass, used to correct the aberration arising from colour in those telescopes which are known by the name of achromatic, because it communicates the property of separating the coloured rays from each other in greater angles than obtain in alkaline glasses at equal angles of mean refraction. The imperfection which most considerably affects this kind of glass is, that its density is seldom uniform throughout. The irregularities show themselves in the forms of veins, which greatly disturb the regular refraction.

Lead is not much altered by exposure to air or water, though the brightness of its surface, when cut or scraped, very soon goes off. It is probable that a thin stratum of oxide is formed on the surface, which defends the rest of the metal from corrosion.

All the oxides of lead are very easily reduced. Minium, when exposed to a strong heat, gives out part of the oxygen it absorbed during its oxidation; but, like the other oxides of this metal, it requires the addition of some combustible substance for its complete revival: a familiar instance of this revival is seen by exposing the common wafers to the flame of a candle. The wafers are coloured with minium, which is revived by the heat and inflammable substance of the wafer, so that it falls down in metallic globules.

Lead is found native, though seldom; and also in the form of an oxide, called native ceruse, or lead ochre, or lead spar, of various colours, red, brown, yellow, green, bluish, and black. These ores, when freed as much as possible from earthy matter, may be dissolved in diluted nitrous acid. Oxide of iron is usually thrown down from the solution by boiling. If the lead be then precipitated by the carbonate of soda, and weighed, 132 grains of the dry precipitate will correspond with 100 grains of lead in the metallic state. If the precipitate be suspected to contain copper, it may be separated by digesting in ammonia. If it be supposed to contain silver and copper, the precipitate may again be dissolved in nitric acid, and separated by the addition of muriatic acid; which, combining with the metal, produces the muriates of silver and of lead; the latter of which, being soluble in thirty times its weight of boiling water, may be washed off, while the silver remains undissolved; or the silver, if alone in the precipitate, may be taken up by ammonia, which will leave the oxide of lead of the same value, with regard to weight, as the foregoing.

Lead is also found mineralized by the sulphuric and the phosphoric acids; this last is of a greenish colour, arising from a mixture of iron. The sulphate of lead is soluble in about eighteen times its weight of water. One hundred and forty-three grains of the dried salt represent 100 grains of lead. The phosphate of lead ore may be dissolved in nitric acid by means of heat, except a few particles of iron, which remain at the bottom. By the addition of sulphuric acid, the lead is thrown down in the form of white flakes of sulphate; which, when washed and dried, discover the quantity of lead they contain, by the same allowance of 143 grains of the salt to 100 grains of metallic lead. The remaining solution being evaporated to dryness, affords phosphoric acid. Lead is abundantly found in combination with sulphur, in the form of heavy, shining, black, or bluish, lead-

coloured cubical masses, whose corners are usually truncated; its texture is laminated, and its hardness variable. This is called galena, or potter's lead ore. Most lead ores contain more or less of silver. When antimony enters into its composition, the texture is radiated or filamentous. There are also lead pyrites, which contain a considerable proportion of iron and sulphur; and red lead spar, which consists of lead mineralized by sulphur and arsenic: this is very scarce.

If sulphuretted lead be boiled in nitric or muriatic acid of a moderate strength, the sulphur may be obtained pure, and collected on a filter. When iron or stony particles are contained among the undissolved part, the sulphur may be separated by digestion in a solution of pure fixed alkali, which converts it into sulphuret, and leaves the other insoluble matters behind. If the first solution be made with nitric acid, it may contain silver and lead, which, after precipitation by carbonate of soda, may be separated by ammonia, as mentioned in the humid analysis of the calciform ores; when the muriatic acid is used for the solution of the ore, a large quantity of muriate of lead separates, for want of a sufficient quantity of water to dissolve it. This requisite quantity of water must be added to dissolve the salt, before the precipitate is made by the fixed alkali.

All the ores of lead, except the phosphoric, are reducible to the metallic state, by dissipating their volatile contents by the blow-pipe on a piece of charcoal. In the large way, they are reduced by fusion with charcoal.

The ores of this metal are abundantly found in the mine counties of England, and in various other parts of the globe. Its uses are numerous, and scarcely need be mentioned. Its oxides are of great use as a pigment, and in the manufacture of glass. Lead is cast into thin sheets for covering buildings, making water-pipes, and various other uses; and this is rolled between two cylinders of iron, to give it the requisite uniformity and thinness. Lead is thought, and with some reason, to be not perfectly innocent, even for water pipes, and much less so for any other kind of vessels. The workmen in any of the preparations of lead are generally subject to a peculiar colic, and paralytic disorders, which most probably arise from the internal use of the metal; for it is a fact, that these workmen are not sufficiently cautious in washing their hands, or removing such particles of lead, or its preparations, as may casually intermix with their food.

Most of the acids attack lead. The sulphuric acid scarcely acts upon it, unless it be concentrated and boiling. Sulphurous acid escapes during the process, the acid being decomposed. When the distillation is carried on to dryness, a saline white mass remains, a small portion of which is soluble in water, and is the sulphate of lead: it affords crystals. The residue of the white mass is an oxide of lead.

Nitric acid acts strongly on lead, and converts it into a white oxide, if the acid be concentrated; but if it be more diluted, the oxide is dissolved, and forms nitrate of lead, which is crystallizable, and does not afford a precipitate by cooling. It detonates on ignited coals. Lime and alkalies decompose the nitrous solution of lead. The sulphuric acid added to this solution combines with the metallic oxide, and falls down. The muriatic acid in the same manner carries down the lead, and forms a combination, which is more soluble in water than the muriate of silver.

Muriatic acid acts directly, but sparingly, on lead by heat, which it oxides, and dissolves in part. The muriate of lead is crystallizable.

The acetic acid dissolves lead and its oxides; though the access of air or oxygen seems necessary for the solution of the metal itself in this acid. White lead, or ceruse, is made by rolling leaden plates spirally up, so as to leave the space of about an inch between each coil, and placing them vertically in earthen pots, at the bottom of which is some good vinegar. The pots are to be covered, and exposed for a length of time to a gentle heat in a sand bath, or by bedding them in dung. The vapour of the vinegar, assisted by the tendency of the lead to combine with the oxygen of the air which is present, corrodes the lead, and converts the external portion into a white oxide, which comes off in flakes when the lead is uncoiled. The plates are thus treated repeatedly, until they are corroded through. Ceruse is the only white substance used in oil paintings. It may be dissolved without difficulty, in the acetous acid, and affords a crystallizable salt, called sugar of lead, from its sweet taste. This, like all the preparations of lead, is poisonous.

The sulphurets precipitate lead from its solutions, the sulphur falling down in combination with the lead. Pure alkaline solutions dissolve a small portion of lead, and corrode a considerable quantity: the solution is said to give a black colour to the hair.

Oils dissolve the oxides of lead, and become thick and consistent; in which state they are used as the basis of plasters, cements for water-works, paints, &c.

In the dry way, lead alone is oxided and vitrified. When fused with fixed alkaline salts, it is converted into a dark coloured scoria, partly soluble in water. The neutral salts in general are not acted upon by lead. Nitre oxides this metal when heated with it, though scarcely any commotion or apparent flame is produced by its action. Sulphur readily dissolves it in the dry way, and produces a brittle compound, of a deep grey colour and brilliant appearance, which is much less fusible than lead itself; a property which is common to all the combinations of sulphur with the more fusible metals.

The phosphoric acid, exposed to heat together with charcoal and lead, becomes converted into phosphorus, which combines with the metal. This combination does not greatly differ in appearance from ordinary lead: it is malleable, and easily cut with a knife; but it loses its brilliancy more speedily than pure lead; and, when fused upon charcoal with the blow-pipe, the phosphorus burns, and leaves the lead behind.

Lead decomposes sal ammoniac, or muriate of ammonia, by the assistance of heat: its oxides unite with the muriatic acid of that salt in the cold, and disengage its volatile alkali. When the volatile alkali is obtained by distilling sal ammoniac with the oxides of lead, the residue consists of the muriate of lead.

Litharge fused with common salt decomposes it; the lead unites with muriatic acid, and forms a yellow compound, at present used in this country as a pigment. The alkali either floats at top, or is volatilized by the heat, if strongly urged. The same decomposition takes place in the humid way, if common salt be macerated with litharge, and the solution will contain the pure alkali.

Lead unites with most of the metals. Gold and silver are dissolved by it in a slight red heat. Both these metals are said to be rendered brittle by a small admixture of lead, though lead itself is rendered more ductile by a small quantity of them. Platina forms a brittle compound with lead; mercury amalgamates with it; but the lead is separated from the mercury by agitation, in the form of an impalpable black powder, if oxygen be present, which is at the same time absorbed. Copper and lead do not unite but with a strong heat. If lead be heated so as to boil and smoke, it soon dissolves pieces of copper thrown into it: the mixture when cold is brittle. The union of these two metals is remarkably slight; for, upon exposing the mass to a heat no greater than that in which lead melts, the lead almost entirely runs off by itself. This process, which is peculiar to lead with copper, is called eliquation. The coarser sorts of lead, which owe their brittleness and granulated texture to an admixture of copper, throw it up to the surface on being melted to a small heat. Iron does not unite with lead, as long as both substances retain their metallic form. Tin unites very easily with this metal, and forms a compound which is much more fusible than lead by itself, and is for that reason used as a solder for lead. Two parts of lead and one of tin, form an alloy more fusible than either metal alone; this is the solder of the plumbers. Bismuth combines readily with lead, and affords a metal of a fine close grain, but very brittle. A mixture of eight parts bismuth, five lead, and three tin, will melt in a heat which is not sufficient to cause water to boil. Antimony forms a brittle alloy with lead. Nickel, cobalt, manganese, and zinc, do not unite with lead by fusion.

It will appear, from the foregoing observations, that the uses of lead are very extensive. It is easily reduced to thin sheets, adapted to the covering of buildings; to be formed into pipes of all sizes, and fitted for divers purposes. Its oxides are used as paints; in the manufacture of glass; and in the glazing of earthen-ware, &c.

Lead, *black*. See the article Iron.

Lead, *sugar of*. A salt, denominated from its composition, by modern chemists, acetite of lead, is much used in calico-printing, and other manufactures.

LEAGUE, a measure of length, containing more or less geometrical paces, according to the different usages and customs of countries. A league at sea, where it is chiefly used by us, being a land measure mostly peculiar to the French and Germans, contains 3,000 geometrical paces, or three English miles. The French league sometimes contains the same measure, and in some parts of France it consists of 3,500 paces: the mean or common league consists of 2,400 paces, and the little league of 2,000. The Spanish leagues are larger than the French, seventeen Spanish leagues making a degree, or twenty French leagues, or sixty-nine and an half

English statute miles. The Dutch and German leagues contain each four geographical miles. The Persian leagues are pretty nearly of the same extent with the Spanish; that is, they are equal to four Italian miles; which is nearly what Herodotus calls the length of the Persian parasang, that contained thirty stadia, eight whereof, according to Strabo, make a mile.

LEAK, among seamen, is a hole in the ship through which the water comes in. To spring a leak, is said of a ship that begins to leak. To stop a leak, is to fill it with a plug wrapt in oakum and well tarred; or putting in a tarpaulin clout, to keep the water out; or nailing a piece of sheet-lead upon the place.

LEAKAGE, the state of a vessel that leaks, or lets water, or other liquid, ooze in or out. See the preceding article. Leakage, in commerce, is an allowance of 12 per cent. in the customs, allowed to importers of wines for the waste and damage it is supposed to have received in the passage: an allowance of two barrels in twenty-two is also made to the brewers of ale and beer by the excise-office.

LEAP *year*, the same with bissextile. See BISSEXTILE. Every centesimal, or hundredth year, is a leap year, according to the Julian account, but according to the Gregorian, it is always a common year, except when the number of centuries can be divided by four without a remainder, for then it is a leap year; but the intermediate centesimal years are common ones: hence, to know if it be leap year, the rule is, If the year consists of complete centuries, and can be divided by 4, it is leap year; as it is also when the intermediate years can be divided by 4: thus the year 1808 is a leap year; for 8 may be divided by 4 without a remainder. If the intermediate years cannot be divided by 4, the remainder shows the number of years over leap year.

LEASE, a conveyance of lands, or tenements, for a term of years, or during the continuance of a life or lives, in consideration of a stipulated rent or other recompense.

The purchaser of a lease may be considered as the purchaser of an annuity equal to the rack-rent, for whether he possesses the estate himself, or lets it out to another, he has an interest in the same equal to the annual rent thereof; therefore, from the principles on which the present value of annuities is ascertained, the value of leases is likewise found. When a certain sum is paid down for the grant of a lease, it may be considered as so much money paid in advance for the annual rents as they may become due; therefore, in order to ascertain what the sum ought to be, it would be necessary to find, separately, the present value of each annual rent, or the sum which, put out to interest at the given rate, would amount to the rent at the time it became due; and these separate values of each year's rent added together would give the sum to be paid down as the present value of the lease. The rate of interest at which money is supposed to be improveable, affects the value of leases very materially, as the higher the current rate of interest is, the less will any one be disposed to give for payments to be received atfuture periods: thus if 6 per cent interest can be readily obtained for money, no one will give the same sum for a certain yearly rent, as if he could only make 4 per cent. interest of his money. Having then determined on the rate of interest at which money is to be improved, it is only necessary to find, at that rate of interest, the present value of an annuity equal to the net yearly rent of the estate, in order to ascertain the value of the lease. This is given, at 5 per cent. interest, in Table II. article ANNUITIES: but as most persons in the purchase of leases, particularly of houses, expect to make rather more than the current interest for money, the following table is better adapted for answering all practical questions relating to this subject.

TABLE

Shewing the Number of Years Purchase to be given for a Lease, of any Number of Years not exceeding 100 years, at 6, 7, and 8 per Cent. Compound Interest.

Years.	6 per Cent.	7 per cent.	8 per cent.	Years.	6 per cent.	7 per cent.	8 per cent.
1	.9433	.9345	.9259	51	15.8130	13.8324	12.2532
2	1.8333	1.8080	1.7832	52	15.8613	13.8621	12.2715
3	2.6730	2.6243	2.5770	53	15.9069	13.8898	12.2884
4	3.4651	3.3872	3.3121	54	15.9499	13.9157	12.3041
5	4.2123	4.1001	3.9927	55	15.9905	13.9399	12.3186
6	4.9173	4.7665	4.6228	56	16.0288	13.9625	12.3320
7	5.5823	5.3892	5.2063	57	16.0649	13.9837	12.3444
8	6.2097	5.9712	5.7466	58	16.0989	14.0034	12.3560
9	6.8016	6.5152	6.2468	59	16.1311	14.0219	12.3669
10	7.3600	7.0235	6.7100	60	16.1614	14.0391	12.3765
11	7.8868	7.4986	7.1389	61	16.1900	14.0553	12.3856
12	8.3838	7.9426	7.5360	62	16.2170	14.0703	12.3941
13	8.8526	8.3576	7.9037	63	16.2424	14.0844	12.4020
14	9.2949	8.7454	8.2442	64	16.2664	14.0976	12.4092
15	9.7122	9.1079	8.5594	65	16.2891	14.1099	12.4159
16	10.1058	9.4466	8.8513	66	16.3104	14.1214	12.4222
17	10.4772	9.7632	9.1216	67	16.3306	14.1321	12.4279
18	10.8276	10.0590	9.3718	68	16.3496	14.1422	12.4333
19	11.1581	10.3355	9.6035	69	16.3676	14.1516	12.4382
20	11.4699	10.5940	9.8181	70	16.3845	14.1603	12.4428
21	11.7640	10.8355	10.0168	71	16.4005	14.1685	12.4470
22	12.0415	11.0612	10.2007	72	16.4155	14.1762	12.4509
23	12.3033	11.2721	10.3710	73	16.4297	14.1834	12.4546
24	12.5503	11.4693	10.5287	74	16.4431	14.1901	12.4579
25	12.7833	11.6535	10.6747	75	16.4558	14.1963	12.4610
26	13.0031	11.8257	10.8099	76	16.4677	14.2022	12.4639
27	13.2105	11.9867	10.9351	77	16.4790	14.2076	12.4666
28	13.4061	12.1371	11.0510	78	16.4896	14.2127	12.4691
29	13.5907	12.2776	11.1584	79	16.4996	14.2175	12.4713
30	13.7648	12.4090	11.2577	80	16.5091	14.2220	12.4735
31	13.9290	12.5318	11.3497	81	16.5180	14.2261	12.4754
32	14.0840	12.6465	11.4349	82	16.5264	14.2300	12.4772
33	14.2302	12.7537	11.5138	83	16.5343	14.2337	12.4789
34	14.3681	12.8540	11.5869	84	16.5418	14.2371	12.4805
35	14.4982	12.9476	11.6545	85	16.5489	14.2402	12.4819
36	14.6209	13.0352	11.7171	86	16.5556	14.2432	12.4833
37	14.7367	13.1170	11.7751	87	16.5618	14.2460	12.4845
38	14.8460	13.1934	11.8288	88	16.5678	14.2486	12.4856
39	14.9490	13.2649	11.8785	89	16.5734	14.2510	12.4867
40	15.0462	13.3317	11.9246	90	16.5787	14.2533	12.4877
41	15.1380	13.3941	11.9672	91	16.5836	14.2554	12.4886
42	15.2245	13.4524	12.0066	92	16.5883	14.2574	12.4894
43	15.3061	13.5069	12.0432	93	16.5928	14.2592	12.4902
44	15.3831	13.5579	12.0770	94	16.5969	14.2610	12.4909
45	15.4558	13.6055	12.1084	95	16.6009	14.2626	12.4916
46	15.5248	13.6500	12.1374	96	16.6046	14.2641	12.4922
47	15.5890	13.6916	12.1642	97	16.6081	14.2655	12.4928
48	15.6500	13.7304	12.1891	98	16.6114	14.2668	12.4933
49	15.7075	13.7667	12.2121	99	16.6145	14.2680	12.4938
50	15.7618	13.8007	12.2334	100	16.6175	14.2692	12.4943

In order to find the value of a lease for any term, the true rack rent of the estate, or the annual value that it may be justly estimated to be worth, must be first ascertained; otherwise it will be impossible to determine, with any degree of accuracy, the real sum which ought to be given for the purchase of the same; for

as the values in the Table denote merely the number of years purchase, it is evident that the sum deduced therefrom will vary according as the annual rent of the estate varies. On this point, difficulties will sometimes arise; for the value of an estate, depending very often on some real or supposed advantages, or on some local or personal recommendations, will, in many instances, occasion a difference of opinion; and, in most cases, be a matter of some uncertainty. Some annual rent must, however, be fixed upon as the full sum for which the estate would let, and this rent being multiplied by the sum in the Table, corresponding with the term of years, gives the present value of the lease. Thus, if a house lets for 50*l.* per ann. to find the value of a lease thereof for 21 years, reckoning interest at 6 per cent. multiply 50 by 11,764 (the sum in the table corresponding with 21 years) which gives the answer 588*l.* 4*s.* It frequently happens that the rent of an estate is charged with some annual expense, such as a reserved or quitrent, the payment of an annuity, taxes, and the like; in such cases, the various charges must be first deducted from the rent received, and the remainder, or nett-rent, only be multiplied by the number of years purchase in the table.

Example. A person holds a lease, for 35 years, of premises which let for 120*l.* per annum, out of which he pays 17*l.* 10*s.* for ground-rent, and 4*l.* 10*s.* for land-tax; what should he require for the lease, allowing the purchaser to make 7 per cent. interest of his money? The payments to which the rent is subject being deducted, leave a nett-rent of 98*l.* which multiplied by 12,948 (the sum in the table corresponding with 35 years) gives 1268*l.* 18*s.*

To find the annual rent corresponding to any given sum paid for a lease, divide the sum by the number of years purchase in the table against the term of the lease, and under the rate of interest intended to be made of the purchase money; the quotient will be the annual rent required.

Example. A person is asked 1250*l.* for a lease of 30 years, what annual rent is equivalent thereto, allowing the purchaser to make 6 per cent. interest of his money? Divide 1250*l.* by 13,765, the years purchase in the table, under 6 per cent. interest, and the answer is 90*l.* 16*s.* 2*d.*

It frequently happens that a tenant is desirous of having the term of his lease renewed before the old lease expires; and if the estate has increased in value since it has been in his possession, it is common, in such cases, for the landlord to demand either an increase of the rent, or a gross sum called a fine, to be paid down in one immediate payment for such renewal. In many leases, particularly those held of colleges and other public bodies, it is covenanted, that renewals shall be granted at the end of a certain number of years, on payment of a fine to be then agreed upon between the parties; the annual rent of the estate continuing the same. This fine is often a subject of dispute, arising principally from a difference of opinion respecting the improved annual value of the estate, or respecting the rate of interest, which each party is endeavouring to make of his money. The former, in some cases, is liable to uncertainty; but, if the latter is once agreed upon, the value of the fine, which ought to be given for renewing a lease of any yearly rent, can, in all cases, be exactly determined.

It is well known, that when a lease is intended to be renewed, such lease is surrendered or delivered up, and a new lease of the estate is granted for a term of years, which includes both the unexpired term of the old lease, and the additional term proposed to be renewed. Now the value which ought to be given for the grant of such additional term, will evidently be be equal to the difference between the value of the lease for the whole term, and the value of the unexpired part thereof, of which the tenant is in actual possession: thus, if a person holds an unexpired term of twenty years in a lease, and is desirous of having ten years more added to it, or of having a new lease granted for the term of thirty years; the fine, or gross sum, which he ought to pay for such renewal, will be equal to the difference between the value of a lease for the whole term of thirty years, and the value of a lease for the unexpired twenty years; this will be easily found from the preceding table.

Example. What fine ought to be given to the landlord for adding seven years more to a lease, of which 14 years are unexpired; allowing the tenant 6 per cent. interest for his money? The whole term for which the new lease is to be granted is 21 years, and the value of a lease for this term, is by the table under 6 per cent. interest 11,764; the value of a lease for fourteen years is found in the same column to be 9,295, and this subtracted from the former sum leaves 2,469 for the

number of years purchase which ought to be given for the fine required. If, therefore, the improved rent of the estate, or the present value beyond the rent payable under the lease, is *50l.* per annum, this improved rent, multiplied by 2,469, will give *123l. 9s.* for the amount of the fine required.

Leases are sometimes granted for a term of years certain, but subject to determine before that period, if a particular life or lives should fail within the term; and the term of such leases being usually greater than the probable duration of the lives, the estate may be considered as wholly depending on the continuance of the life or lives nominated.

Life estates are of various kinds; some depend on a single life, of which kind may be considered church-livings, tenancies by courtesy, in dower, &c.; others are granted for two lives, such as joint-tenancies, and joint-tenancies with benefit of survivorship, the former signifying such estates as terminate on the death of either of the parties, and the latter signifying such as terminate on the death of both the parties; other estates are granted for three lives, which, like the last, may be divided into such as depend on the joint continuance of all the lives, and such as depend on the longest of all the lives; the former signifying such as terminate on the death of any one of the parties, and the latter such as terminate on the death of the longest liver of the three lives. When estates are held on two or three lives, and one of the lives, nominated in the lease, happens to drop, or become extinct, the tenant is often desirous of replacing such life, or of putting in a new life, in order that the estate may continue to be held on the same number of lives in being, and thereby his interest in the same be prolonged. In such cases it is customary, if the estate has improved in value since the original grant of the lease, for the landlord to demand a fine, or sum of money, proportionate to such improved value, and to the age of the person intended to be put to it, or added to those already in possession; the annual rent of the estate continuing the same. It is evidently the interest of the tenant, in this case, to add one of the best lives he can find, that is, a life which has the greatest expectation of living, according to the best tables of mortality, and such a life will be about the age of eight or ten years. However, it will sometimes happen that he may wish to put in a life not exactly of this age, but as it is his interest to put in as good a life as possible, few persons will be disposed to put in one above the age of twenty. The following table will, therefore, comprehend the cases of this kind which most commonly occur, from which the sums to be paid for renewing with a life of any other age may be nearly determined.

TABLE, for renewing, with One Life, the Lease of an Estate held on Three Lives. Interest at 6 per Cent.

Life put in.	Lives in Possession.	Years Purchase.	Life put in.	Lives in Possession.	Years Purchase.	Life put in.	Lives in Possession.	Years Purchase.
	30–30	1.305		30–30	1.191		30–30	1.079
	30–40	1.521		30–40	1.407		30–40	1.284
	30–50	1.832		30–50	1.699		30–50	1.557
	30–60	2.160		30–60	1.996		30–60	1.831
	30–70	2.535		30–70	2.381		30–70	2.218
	30–75	2.571		30–75	2.408		30–75	2.241
	40–40	1.792		40–40	1.687		40–40	1.558
	40–50	2.204		40–50	2.067		40–50	1.908
	40–60	2.637		40–60	2.474		40–60	2.293
10	40–70	3.032	15	40–70	2.839	20	40–70	2.641
	40–75	3.273		40–75	3.076		40–75	2.873
	50–50	3.723		50–50	2.536		50–50	2.341
	50–60	3 242		50–60	3.039		50–60	2.828
	50–70	3.819		50–70	3.579		50–70	3.337
	50–75	4.062		50–75	3.819		50–75	3.576
	60–60	3.911		60–60	3.678		60–60	3.433
	60–70	4.917		60–70	4.627		60–70	4.338
	60–75	5.142		60–75	4.849		60–75	4.558
	70–70	6.124		70–70	5.805		70–70	5.489

The years purchase in the table, multiplied by the improved annual value of the estate beyond the rent payable under the lease, gives the fine to be paid for putting in the new life.

Lease, in law, otherwise called a Demise, is a conveyance or letting of lands or tenements, in consideration of rent, or other annual recompense made for life, for years, or at will; but always for a less time than the interest of the lessor in the premises; for if it were of the whole interest, it would be more properly an assignment. He that demises or lets, is the lessor; and he to whom it is demised or let, is the lessee.

A lease may either be made by writing or word of mouth, called in law, a lease by parol. The former is most usual; but by the statute of frauds, 29 Charles II. c. 3, all leases of lands, except leases not exceeding three years, must be made in writing, and signed by the parties themselves, or their agents duly authorized, otherwise they will operate only as leases at will. If a lease is but for half a year, or a quarter, or less time, the lessee is respected as a tenant for years; a year being the shortest term of which the law, in this case, takes notice; that is, he is entitled to the general privileges of a tenant for years, and is classed as such, though his term lasts only for the time specified.

To constitute a good lease, there must be a lessor not restrained from making the lease to the extent for which it is granted; a lessee capable of receiving it; and the interest demised must be a demisable interest, and be sufficiently and properly described. If it is for years, it must have a certain commencement and determination; it is to have all the usual ceremonies, as sealing, delivery, &c.; and there must be an acceptance of the thing demised.

Leases were formerly only to a sort of bailiffs, who tilled the land, and paid a part of the profits to the landlord; they were for very short terms, and the tenant's estate was little respected in the law. They are now granted for long terms, and are very beneficial interests.

The following points may be necessary to be specified here concerning leases. First, they must have a certain commencement and end. Leases for life must not be made to commence at a future day, and there must be a livery of seisin. They must now be stamped as a lease, to be valid; and any form of writing will constitute a lease, provided it contains words of present demise, or actual letting: but if it be only an agreement to let, it conveys no immediate title in law, but only an equitable right to have a lease, or to sue at law for not making one. If a lease is made to one for years, and at the same time to another for a longer time, the last lease is not void, but shall take effect after the first expires. A tenant for life can, in general, only grant a lease to enure during his life; but sometimes a power is annexed to such an estate, to grant leases for a specified time, and under particular limitations, all which must be strictly complied with, or the lease is void; and instances have happened, where building-leases have been set aside, and persons ruined by having granted under-leases. An infant may make a lease; but may set it aside when he comes of age; and the Court of Chancery is empowered to grant leases for idiots, lunatics, infants, and married women.

The rent must be reserved to the executor or the heir of the lessor, according as his estate is real or personal. Lessees are bound to repair, unless the contrary is specified; and although, if the house is burnt by accident, they are not bound to rebuild, yet they must if the fire be by negligence; and if there is a covenant to pay rent, and a covenant to repair, except in case of fire, yet rent is payable, although the house is not rebuilt by the landlord. If there is a covenant not to assign, lease, or under-let, without licence of the landlord, the tenant cannot even grant an under-lease.

Upon a lease at will, six months' notice to quit must generally be given by either party, to determine on the same day in the year when the lease commenced. Leases made by spiritual persons of their church-lands, must be strictly conformable to certain statutes, called the enabling and disabling statutes. The tenant may, at the trial of an ejectment, insist upon his notice to quit being insufficient, although he made no objection when it was served. See further Jacob's "Law Dictionary," title Leases.

Lease and Release, a conveyance of the fee simple, right, or interest, in lands or tenements, under the statute of uses, 27 Henry VIII. c. 10, giving first the possession, and afterwards the interest, which in law is equivalent to a feoffment. It was invented to supply the place of livery of seisin, and is thus contrived; a lease, or rather bargain and sale, upon some pecuniary consideration, for one year, is made by the tenant of the free-

hold to the lessee or purchaser, which vests in him the use of the term for a year; and then the statute of uses, 27 Henry VIII. c. 10, immediately transfers the use into possession. He therefore, being thus in possession, is capable of receiving a release of the freehold and reversion; and, accordingly, the next day a release is granted to him.

This conveyance was invented by Serjeant Moore, soon after the statute of uses, and the principle upon which it is founded has been properly questioned, there being no actual entry in general under the lease, before the release is made. When a corporation conveys, either a feoffment or actual entry is still necessary. But this mode of conveyance having been long adopted, and in constant practice, its validity cannot now be questioned. This conveyance does not properly operate, unless there is either an actual entry, or a lease with a valuable consideration, as a bargain and sale for a year.

LEATHER, the skin of several sorts of beasts dressed and prepared for the use of the various manufacturers, whose business it is to make them up. The butcher and others, who flay off their hides or skin, dispose of them raw or salted to the tanner and tawyer, and they to the shamoy, morocco, and other kind of leather-dressers, who prepare them according to their respective arts, in order to dispose of them among the curriers, glovers, harness-makers, coach-makers, saddlers, breeches-makers, gilt leather-makers, chair-makers, shoe-makers, book-binders, and all in any way concerned in the article of leather.

The three principal assortments of leather are, tanned or tawed, and oil and alum-leather; and it may be affirmed, with great truth, that the skins of our own production, and those imported from our colonies, when dressed in this kingdom, make the best leather in the world, and that therefore this is an article of great importance to the trade of the nation.

Though there is no little difference between the dressing of shamoy-leather, alum-leather, Hungary leather, Morocco leather, parchment, and tanning; yet the skins which pass through the hands of these several workmen, ought to have been for the most part, at least, washed clean from blood and impurities in a running water; set to drain, worked with the hands, or pounded with wooden pestles in a vat; put into the pit (which is a hole lined either with wood, or with stone and mortar) filled with water in which quick-lime is dissolved, in order to loosen the hair, that it may be easily rubbed off without injuring the skin; drawn out, and set to drain on the edge of the pit; stretched on the leg or horse, in order to have the hair scraped off with a blunt iron knife, or wooden cylinder: the membranes on the fleshy side, and the scabs or roughness on the grain side pared off with a sharp knife, and the skins rubbed with a whetstone, to take off any particles of the lime, or any thing else that may occasion hardness; thickened by different sorts of powder, whereby they become greater in bulk, and so much lighter, as gradually to rise to the surface of the water; stretched out green or half dried, and piled one over another; or put up separate after they are dried, and hung out to air upon poles, lines, or any other way; which must be repeatedly done in the dressing of small skins. This alternate transition from the liquid of the air into that of water, and from water into the air, with the assistance of lime, salts, and oils, opens the inmost fibres of the skin so effectually, as greatly to facilitate the introduction of substances proper for making them pliant without rendering them thinner.

The alum-leather dresser dresses all sorts of white leather, from the ox-hide to the lamb-skin; for dressing the saddler's leather, he uses bran, sea-salt, and alum; and for that which the glover uses, after the common preparatives, he first employs bran, and then with salt, alum, fine flour, and yolks of eggs mixed in hot water, he makes a sort of pap, with which the skins are smeared in a trough. The shamoy leather-dresser soaks in oil, not only the skins of the true shamoy, which is a wild goat, but likewise those of all other goats. The tanner uses the bark of young oaks ground in a tanning mill, in which he soaks the skins more or less, according to the different services expected from them, their chief use being to remain firm and keep out water. In certain cases, instead of tan, he uses redon, which is chiefly used for tanning ram sheep-skins, and dressing Russia leather. But for the different methods in which the tanner, currier, Russia, and Morocco leather-dressers, proceed in finishing their skins, see CURRYING, TANNING, &c.

LEAVEN. See BREAD.

LECHEA, in botany, so named from John Leche, professor at Aboa, in Sweden,

a genus of the Triandria Trigynia class and order. Natural order of Caryophyllei. Essential character: calyx three-leaved; petals three, linear; capsule three-celled, three-valved, with as many internal ones; seeds solitary. There are three species, natives of North America, and of China near Canton.

LECYTHIS, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Myrti, Jussieu. Essential character: calyx six-leaved; corolla six-petalled; nectary ligulate, staminiferous; pericarpium circumcised, many-seeded. There are six species. These are trees or shrubs, with alternate leaves; flowers in terminating spikes from the axils of the shoots. It is peculiar to this genus to have a pitcher-shaped body in the centre of the flower, which Linnæus calls the nectarium, inserted into the calyx below the petals, perforated in the middle for the passage of the style, shaped like a petal, coriaceous entire at the edge, but covered on the inside with numerous subsessile stamens. Native of the forests of Guiana.

LEDUM, in botany, a genus of the Decandria Monogynia class and order. Natural order of Bicornes. Rhododendra, Jussieu. Essential character; calyx five-cleft; corolla flat, five-parted; capsule five-celled, gaping at the base. There are three species, all natives of the North of Europe. These shrubs growing on mosses or bogs, where the roots spread freely, cannot be preserved in gardens, as least so as to thrive, but in a proper soil and a shady situation.

LEE, an epithet to distinguish that half of the horizon to which the wind is directed from the other part whence it arises, which latter is accordingly called to windward. This expression is chiefly used when the wind crosses the line of a ship's course, so that all on one side of her is called to windward, and all on the opposite side to leeward; and hence "Lee side," all that part of a ship or boat which lies between the mast and the side farthest from the direction of the wind; or that half of a ship which is pressed down towards the water by the effort of the sails, as separated from the other half by a line drawn through the middle of her length: that part of the ship which lies to the windward of this line is accordingly called the weather-side. Thus, if a ship sail southward with the wind at east, then is her starboard, or right side, the lee-side; and the larboard, or left, the weather-side.

Lee *way*, or Leeward *way*, is the lateral movement of a ship to the leeward of her course, or the angle which the line of her way makes with her keel when she is close hauled. This movement is produced by the mutual effort of the wind and sea upon her side, forcing her to leeward of the line upon which she appears to sail, and in this situation her course is necessarily a compound of the two motions by which she is impelled. All ships are apt to make some lee-way; so that in casting up the log-book something must be allowed for lee-way. But the lee-way made by different ships, under the same circumstances, will be different: and even the same ship, with different lading, and having more or less sail on board, will make more or less lee-way.

However, the common allowances made for lee-way, are these: 1. If the ship be close hauled, has all her sails set, the water smooth, and a moderate gale of wind, she is supposed to make little or no lee-way. 2. If it blow so fresh, as to cause the small sails to be handed, it is usual to allow one point. 3. If it blow so hard, that the tops must be close reefed, the ship then makes about two points lee-way. 4. If one topsail must be handed, it is common to allow two and three quarters, or three points lee-way. 5. When both topsails must be handed, they allow about four points lee-way. 6. When it blows so hard, as to occasion the fore-course to be handed, the allowance is between five and a half and six points. 7. When both main and fore-courses must be handed, then six, or six and a half points must be allowed for her lee-way. 8. When the mizen is handed, and the ship is trying a hull, she then makes her way good about one point before the beam, that is, about seven points lee-way.

Though these rules are such as are generally used, yet as the lee-way depends much upon the mould and trim of the ship, we shall here give the method of ascertaining it by observation. Thus, let the ship's wake be set by a compass in the poop, and the opposite rhumb is the true course made good by the ship; then the difference between this, and the course given by the compass in the bittacle, is the lee-way required. If the ship be within sight of land, the lee-way may be exactly found by observing a point on the land which continues to bear the same way; for the distance between the point of the compass it lies on, and the point the ship capes at, will be the lee-way.

LEEA, in botany, so called from James Lee, a genus of the Pentandria Monogynia class and order. Natural order of Trihilatæ. Sapotæ, Jussieu. Essential character: corolla one-petalled; nectary on the tube of the corolla, upright, five-cleft; berry five-seeded. There are three species, natives of the East Indies, Africa, and New South Wales.

LEECH. See HIRUDO.

LEEK. See ALLIUM.

LEERSIA, in botany, so named from John Daniel Leers, a genus of the Triandria Digynia class and order. Natural order of Gramina or Grasses. Essential character: calyx none; glume two-valved, closed. There are three species.

LEGACY, is a bequest of a sum of money, or any personal effects of a testator, and these are to be paid by his representative, after all the debts of the deceased are discharged, as far as the assets, or property liable to payment of debts and legacies, will extend. All the goods and chattels of the deceased are by law vested in the representative, who is bound to see whether there be left a sufficient fund to pay the debts of the testator, which, if it should prove inadequate, the pecuniary legacies must proportionably abate; a specific legacy, however, is not to abate, unless there be insufficient without it to pay debts; that is, the general legacies must all be exhausted first. If the legatee die before the testator, it will in general be a lapsed legacy, and fall into the general fund, as it will also where it is given upon a contingency, as to A B, if he shall attain twenty-one. Where, however, from the general import of the will, it can be collected that the testator intended it a vested legacy, it will go to the representative of the deceased legatee. Thus, if a legacy is made payable, or to be paid, to the legatee at a certain age, and he die under that age, it is a vested and transmissible interest in him; but it is otherwise, if it is generally to him at or when he attains such age. If the legacy is to bear interest, it is vested, though the words payable are omitted. So, if it is to A for life, and after the death of A to B, the legacy to B is vested in B, upon the death of the testator, and will not lapse by the death of B in the lifetime of A.

In case of a vested legacy due immediately, and charged on land, or money in the funds, which yield an immediate profit, interest shall be payable from the death of the testator; but if it be charged on the personal estate only of the testator, which cannot be collected in, it will carry interest only from the end of the year after the death of the testator. A legacy to an infant ought not to be paid to his father; a legacy to a married woman can only be paid to her husband; and executors are not bound to pay a legacy without security to refund.

When all the debts and particular legacies are discharged, the residue or surplus must be paid to the residuary legatee, if any be so appointed in the will; but if there be none appointed or intended, it will go to the executor or next of kin. When this residue does not go to the executor, it is to be distributed among the intestate's next of kin, according to the statute of distributions, except it is otherwise disposable by particular customs, as those of London, York, &c. See EXECUTOR.

LEGNOTIS, in botany, a genus of the Polyandria Monogynia class and order. Essential character: calyx five-cleft; petals five, jagged, inserted into the receptacle; capsule three-celled There are two species, *viz.* L. elliptica and L. cassipourea.

LEGUMEN, in botany, that species of seed-vessel termed a pod, in which the seeds are fastened along one suture only. In this the seed-vessel in question differs from the other kind of pod, termed by botanists siliqua, in which the enclosed seeds are fastened alternately to both the sutures or joinings of the valves. The seed-vessel of all the pea-bloom or butterfly-shaped flowers, the Diadelphia of Linnæus, is of the leguminous kind; such is the seed-vessel of the pea, vetch, lupine, &c. See PAPILIONACEOUS.

LEIBNITZ (GODFREY WILLIAM,) an eminent mathematician and philosopher, was born at Leipsic, in Saxony, in 1646. At the age of fifteen, he applied himself to mathematics at Leipsic and Jena; and in 1663, maintained a thesis de Principiis Individuationis. The year following he was admitted Master of Arts. He read with great attention the Greek philosophers, and endeavoured to reconcile Plato with Aristotle, as he afterwards did Aristotle with Des Cartes. But the study of the law was his principal view; in which faculty he was admitted Bachelor in 1665. The year following he would have taken the degree of Doctor, but was refused it on pretence that he was too young; though, in reality, because he had raised himself many enemies, by rejecting the principles of Aristotle and the schoolmen.

Upon this he repaired to Altorf, where he maintained a thesis de Casibus Perplexis with such applause, that he had the degree of Doctor conferred on him.

In 1672 he went to Paris, to manage some affairs at the French court for the Baron Boinebourg. Here he became acquainted with all the literati, and made further and considerable progress in the study of mathematics and philosophy; chiefly, as he says, by the works of Pascal, Gregory, St. Vincent, and Huygens. In this course, having observed the imperfections of Pascal's arithmetical machine, he invented a new one, as he called it, which was approved by the minister Colbert and the Academy of Sciences, in which he was offered a seat as a member, but refused the offers made to him, as it would have been necessary to have embraced the Catholic religion.

In 1673 he went over to England, where he became acquainted with Mr. Oldenburgh, Secretary to the Royal Society, and Mr. John Collins, a distinguished member of that society; from whom, it seems, he received some hints of the method of fluxions, which had been invented in 1664, or 1665, by the then Mr. Isaac Newton.

The same year he returned to France, where he resided till 1676, when he again passed through England and Holland, in his journey to Hanover, where he proposed to settle. On his arrival there, he applied himself to enrich the Duke's library with the best books of all kinds. The Duke dying in 1679, his successor, Ernest Augustus, then bishop of Osnaburg, shewed M. Leibnitz the same favour as his predecessor had done, and engaged him to write the history of the House of Brunswick. To execute this task, he travelled over Germany and Italy to collect materials. While he was in Italy he met with a pleasant adventure, that might have proved a more serious affair. Passing in a small bark from Venice to Messola, a storm arose; during which the pilot, imagining he was not understood by a German, whom, being a heretic, he looked on as the cause of the tempest, proposed to strip him of his clothes and money, and to throw him overboard. Leibnitz, hearing this, without discovering the least emotion, drew a set of beads from his pocket, and began turning them over with great seeming devotion. The artifice succeeded; one of the sailors observing to the pilot, that since the man was no heretic, he ought not to be drowned.

In 1700 he was admitted a member of the Royal Academy of Sciences at Paris. The same year the Elector of Brandenburg, afterwards King of Prussia, founded an academy at Berlin by his advice; and he was appointed perpetual President, though his affairs would not permit him to reside constantly at that place. He projected an academy of the same kind at Dresden: and this design would have been executed, if it had not been prevented by the confusions in Poland. He was engaged likewise in a scheme for an universal language, and other literary projects. Indeed his writings had made him long before famous all over Europe, and he had many honours and rewards conferred on him. Beside the office of Privy Counsellor of Justice, which the Elector of Hanover had given him, the Emperor appointed him, in 1711, Aulic Counsellor; and the Czar made him Privy Counsellor of Justice, with a pension of 1,000 ducats. Leibnitz undertook, at the same time, to establish an academy of sciences at Vienna; but the plague prevented the execution of it. However, the Emperor, as a mark of his favour, settled a pension on him of 2,000 florins, and promised him one of 4,000, if he would come and reside at Vienna; an offer he was inclined to comply with, but was prevented by the death of that prince.

Meanwhile, the History of Brunswick being interrupted by other works, which he wrote occasionally, he found, at his return to Hanover in 1714, that the Elector had appointed Mr. Eccard for his colleague in writing that history. The Elector was then raised to the throne of Great Britain, which place Leibnitz visited the latter end of that year, when he received particular marks of friendship from the King, and was frequently at court. He now was engaged in a dispute with Dr. Samuel Clarke, upon the subjects of free-will, the reality of space, and other philosophical subjects. This was conducted with great candour and learning, and the papers which were published by Clarke will ever be esteemed by men of genius and learning. The controversy ended only with the death of Leibnitz, November 14, 1716, which was occasioned by the gout and stone, in the 70th year of his age.

As to his character and person: he was of a middle stature and a thin habit of body. He had a studious air, and a sweet

aspect, though near-sighted. He was indefatigably industrious to the end of his life. He eat and drank little. Hunger alone marked the time of his meals, and his diet was plain and strong. He had a very good memory, and it is said, could repeat the Æneid from beginning to end. What he wanted to remember he wrote down, and never read it afterwards. He always professed the Lutheran religion; but he never went to sermons; and when in his last sickness his favourite servant desired to send for a minister, he would not permit it, saying he had no occasion for one. He was never married, nor ever attempted it but once, when he was about fifty years old; and the lady desiring time to consider of it, gave him time to do the same: he used to say, "that marriage was a good thing; but a wise man ought to consider of it all his life."

Leibnitz was author of a great multitude of writings, several of which were published separately, and many others in the memoirs of different academies. He invented a binary arithmetic, and many other ingenious matters. His claim to the invention of fluxions was the subject of much controversy, for which the authors of the time may be consulted.

Hanschius collected with great care every thing which Leibnitz had said in different passages of his works on the principles of philosophy; and formed of them a complete system, under the title of "G. G. Leibnitzii Principia Philosophiæ more geometrico demonstrata, &c." 1728, in 4to. There came out a collection of our Author's letters in 1734 and 1735, entitled "Epistolæ ad diversos theologici, juridici, medici, philosophici, mathematici, historici, et philologici augmentile MSS. auctores: cum annotationibus suis primum divulgavit Christian Cortholtus." But all his works were collected and distributed into classes by M. Dutens, and published at Geneva in six large volumes, 4to., in 1768, entitled "Gothofredi Gulielmi Leibnitzii Opera Omnia, &c."

LEMMA, in mathematics, denotes a previous proposition, laid down in order to clear the way for some following demonstration; and prefixed either to theorems, in order to render their demonstration less perplexed and intricate, or to problems, to make their resolution more easy and short. Thus, to prove a pyramid one-third of a prism, or parellelopiped, of the same base and height with it, the demonstration whereof, in the ordinary way, is difficult and troublesome, this lemma may be premised, which is proved in the rules of progression, that the sum of the series of the squares, in numbers in arithmetical progression, beginning from 0, and going on 1, 4, 9, 16, 25, 36, &c., is always subtriple of the sum of as many terms, each equal to the greatest; or is always one-third of the greatest term multiplied by the number of terms. Thus, to find the inflection of a curve line, this lemma is first premised, that a tangent may be drawn to the given curve in a given point.

LEMNA, in botany, a genus of the Monoecia Diandria class and order. Natural order of Miscellaneæ. Naiades, Jussieu. Essential character: male, calyx one-leafed; corolla none: female, calyx one-leafed; corolla none; style one; capsule one-celled. There are six species. These plants are well known by the name of "duck's meat," or "duck weed." They are all annuals, and are found floating on stagnant water. They are natives of most parts of Europe, in ditches, ponds, &c.

LEMNISCIA, in botany, a genus of the Polyandria Monogynia class and order. Essential character: calyx five-toothed; corolla five-petalled, recurved; nectary cup-shaped, girding the germ; pericarpium five-celled; seeds solitary. There is but one species, *viz.* L. guianensis. The trunk of this tree is about twenty feet in height, and one foot in diameter; the bark is brown and smooth; the wood is white and compact; abundance of twisted branches spread in every direction; leaves alternate, firm, and smooth; flowers at the ends of the shoot, very numerous, in large corymbs, on a woody peduncle: corolla of a fine coral red. Native of Guiana.

LEMON. See CITRUS.

LEMONS, *salt of*, used to remove ink-stains from linen, is the native salt of sorrel, the super-oxalate of potash. The effect is produced by the oxalic acid dissolving with facility the oxide of iron in the ink, on the combination of which with the tannin and gallic acid the colour depends; while, at the same time, it can be used without any risk of injury to the cloth, on which it has no effect. See OXALATE.

LEMONADE, a liquor prepared of water, sugar, and lemon or citron juice. It is very cooling and grateful.

LEMUR, the *macauco*, in natural history, a genus of Mammalia, of the order

Primates. Generic character: in the upper jaw four front teeth, the intermediate ones remote; in the lower jaw, six longer, extended forwards, compressed, parallel, and approximated; tusks solitary and approximated; grinders several, and sometimes many, sublobated, the foremost somewhat longer and sharper. This genus of animals is very similar to that of monkeys in the structure of the feet. Some are destitute of a tail, and others have extraordinary long ones. Their manners are very different from those of monkeys, and display nothing of the active mischief and intrusive impertinence of that animal. There are thirteen species, of which we shall notice the following:

L. tardigradus, or the loris. This is of a light brown colour, and of the usual size of a cat. It walks and climbs with great slowness, and is supposed incapable of leaping. Its manners are gentle and interesting, it is extremely susceptible of cold, and when exposed to a strong degree of it is agitated with extreme uneasiness, and with considerable exasperation. It sleeps from sun-rise to sun-set without intermission, rolled up in the manner of the hedge-hog; it is extremely attentive to cleanliness, licking its full and rich fur with the same assiduity as a cat. Its food consists of plantains, mangoes, and other fruits, and it is scarcely capable of satisfying itself with grasshoppers when it has access to them. Many species of insects, indeed, form a repast particularly gratifying to it, and the sight of them excites in its look the most glowing animation, and summons to exertion all the energies of its frame. Several of the above particulars are taken from an account given of one kept in a state of confinement by the late Sir William Jones. It is a native of various parts of India.

L. indri, is a native of Madagascar, is the largest of the genus, has a face of a dog-like form, and a fur thick and soft. It has no appearance of a tail: it is very docile, and sometimes trained by the natives to hunt various animals. It is three feet and a half in height.

L. macauco, or the ruffed macauco, is found in some of the Indian islands, and is particularly numerous at Madagascar. It is full of energy and fierceness, and its voice is so strong as to fill the woods with its cries. It will endure captivity, notwithstanding the violent passions it exhibits in a natural state, without discontent or depression, and is stated to be extremely inoffensive, and even sociable in it, with those by whom it is surrounded. It possesses neither craft nor malice in it.

L. catta, or the ring-tailed macauco. In their state of nature these animals are seen in companies of twenty or thirty. They feed on almost every species of fruits, and in a state of confinement, like several others of this genus, will take animal food without any hesitation. They are the most elegant and beautiful species of the whole genus, are lively and gentle, and so agile and elegant in their movements, as to be highly interesting. They delight much in sunshine, and will sit before a fire, like the squirrel, extending towards it their out-spread hands. It inhabits Madagascar, is of the size of a small cat, and resembles that animal in purring. See Mammalia, Plate XV. fig. 1. and 2.

LENS, dioptrics, properly signifies a small roundish glass, of the figure of a lentil, but is extended to any optic glass, not very thick, which either collects the rays of light into a point, in their passage through it, or disperses them further apart, according to the laws of refraction.

Lenses have various figures, that is, are terminated by various surfaces, from which they acquire various names. Some are plane on one side, and convex on the other; others convex on both sides; both which are ordinarily called convex lenses: though, where we speak accurately, the former is called plano-convex. Again, some are plane on one side, and concave on the other; and others are concave on both sides; which are both usually ranked among the concave lenses; though, when distinguished, the former is called a plano-concave. Others, again, are concave on one side, and convex on the other, which are called convexo-concave, or concavo-convex lenses, according as the one or the other surface is more concave, or a portion of a less sphere. It is here to be observed, that in every lens terminated in any of the forementioned manners, a right line, perpendicular to the two surfaces, is called the axis of the lens; which axis, when both surfaces are spherical, passes through both their centres; but if one of them be plane, it falls perpendicularly upon that, and goes through the centre of the other. See Optics.

LEO, in astronomy, one of the twelve signs of the zodiac, the fifth in order. See Astronomy.

LEONTICE, in botany, a genus of the Hexandria Monogynia class and order.

Natural order of Corydales. Berberides, Jussieu. Essential character: calyx six-leaved, deciduous; corolla six-petalled; nectary six leaved, placed on the claws of the corolla, spreading. There are three species.

LEONTODON, in botany, *dandelion*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosi. Cichoraceæ, Jussieu. Essential character: calyx imbricate, with loosish scales; down capillary; receptacle naked, dotted. There are four species, of which L. taraxacum, dandelion, is common all over Europe, in meadows, on walls, dry banks, &c.; it flowers from April to September; the flowers expand about five or six in the morning, closing early in the afternoon; as the flower advances, the calyx is gradually pressed out at top, and when the flowering is past, it contracts again into a conical form, and finally when the seeds are mature, the calyx is again pushed back, and the aggregate of down assumes a spherical form, till the whole is loosened and dissipated by the wind.

LEONORUS, in botany, *lion's tail*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: anthers having shining dots sprinkled over them. There are five species.

LEPAS, in natural history, *acorn-shell*, a genus of the Vermes Testacea class and order. Animal a triton; shell affixed at the base, and consisting of many unequal, erect valves. There are upwards of thirty species. L. balanus, shell conic, grooved; operculum or lid, sharp-pointed: it inhabits the European and Mediterranean seas, adhering in the greatest abundance to rocks, shells, &c.; generally whitish; with about six outer valves, three of which are elevated and striate, and three excavated and smoother; the pieces composing the lid, are finely crenate with transverse wrinkles, two lesser and two larger, and pointed. L. anatifera, duck-barnacle, shell compressed, five-valved, smooth, seated on a peduncle: of this there are several varieties, which inhabit most seas; they are generally found fixed in clusters to the bottoms of vessels and old pieces of floating timber; whitish, with a blue cast, the margins of the valves yellow, sometimes marked with a ray or two dotted with black; peduncle long, coriaceous, black, and very much wrinkled towards the shell, and growing paler and pellucid towards the base, extensile; sometimes, though not often, red. The tentacula are feathered, which gave the old English naturalists the idea of a bird. They ascribed the origin of the barnacle-goose to these shells.

LEPIDIUM, in botany, *pepper-wort*, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ, or Cruciformes. Cruciferæ, Jussieu. Essential character: silicle emarginate, cordate, many-seeded; valves keeled, contrary. There are twenty-three species, of which L. perfoliatum, various-leaved pepper-wort, is an annual plant, about a foot in height; the stem is round, upright, and smooth, tinged with purple, dividing into many slender branches; flowers in corymbs, or long, loose spikes, from the ends of the branches; silicles orbiculate, scarcely emarginate, and the terminating style so short as to be hardly visible. It is a native of Austria and the Levant.

LEPIDOPTERA, or *scaly-winged*, the third order of insects, according to the Linnæan system. The general character of this order is four wings, covered with fine imbricate scales; tongue involute, spiral; body hairy. It consists of the insects commonly termed butterflies and moths. There are three genera, *viz*.

Papilio	Sphinx
Phalæna	

The powder on the wings of these insects has been generally described by microscopical writers as consisting of small feathers; but they are more in the form of minute scales, of various shapes and sizes, on the different species, and even on the different parts of the same animal. Their usual appearance is more or less fan-shaped, and they are disposed in the manner of tiles on a roof, lapping over each other. See Papilio, &c.

LEPISMA, in natural history, a genus of insects of the order Aptera; lip membranaceous, rounded, emarginate; four feelers, of which two are setaceous, and two capitate; antennæ setaceous; body imbricate, with scales; tail ending in setaceous bristles; six legs, formed for running. There are seven species enumerated, of these the principal is L. saccharina; scaly, silvery, lead-colour, with a triple tail. It inhabits America, among sugar, but is naturalized in Europe, and found among old books and furniture; it runs exceedingly swift, and is difficult to catch. In their various stages of existence these insects prey upon sugar, decayed wood, and rotten substances; the larva and pupa are six-footed, active, and swift.

LEPROSO *amovendo*, an ancient writ to

remove a leper, who came to church or to public meetings, to annoy his neighbours; but it could only lie when the party appeared outwardly unwholesome by his sores and smell; and if he kept at home, it could not be enforced. It seems to have been a wise provision for the health of the public.

LEPTOCEPHALUS, the *morris*, in natural history, a genus of fishes of the order Apodes. Generic character: head small and narrow, body exceedingly thin, compressed; no pectoral fins. This fish was first discovered near the isle of Anglesea, by a gentleman of the name of Morris. It is four inches long, with an exceedingly small head, and a body so thin as to be nearly transparent; on a slight view, it might almost be considered as a tape-worm.

LEPTOSPERMUM, in botany, a genus of the Icosandria Monogynia class and order. Natural order of Myrti. Essential character: calyx five-cleft, half superior; petals five, with claws, longer than the stamens; stigma capitate; capsule four or five-celled; seeds angular. There are eleven species, of which L. scoparium is a small tree or shrub, growing to a moderate height, generally bare on the lower part, with a number of small branches growing close together towards the top; the younger ones are silky: it grows commonly in dry places near the shores in New Zealand; the underwood in Adventure-bay, Van Diemen's land, chiefly consists of this shrub; the leaves were used by Captain Cook's ships' crews as tea, whence they named it the tea-plant; the leaves have a very agreeable flavour, and a pleasant smell when fresh; if the infusion was made strong, it proved an emetic to some, in the same manner as green tea; it was also used with spruce leaves, in equal quantities, to correct their astringency in brewing beer for them, which rendered it exceedingly palatable.

LEPTURA, in natural history, a genus of insects of the order Coleoptera. Antennæ setaceous; four feelers filiform; shells tapering towards the tip; thorax slender, rounded. There are nearly one hundred and fifty species, in two divisions, *viz.* A. lip entire; B. lip bifid. Many of the species of this genus are very beautiful; among these may be mentioned L. arcuata, of a black colour, with wing-sheaths marked by transverse yellow; lunated bands pointing backwards. It is a native of Europe, and is found in the woods during the summer months, and generally measures about three-quarters of an inch in length. L. aquatica, is so named from its being particularly found in the neighbourhood of waters, frequently on the plants which grow near the water's edge. It is only half an inch in length, and of a golden green colour, sometimes varying into copper-colour, purple, or blue, and is distinguished by having a tooth or process on the thighs of the legs.

LEPUS, the *hare*, in natural history, a genus of Mammalia, of the order Glires. Generic character: two fore-teeth above and below; the upper pair double, two small ones standing within the exterior. These animals exhibit several considerable differences from those of the order Glires in general, to which, however, upon the whole, they are with more propriety attached than to any other. By an appearance of rumination, they appear somewhat connected with the Pecora. There are fifteen species, of which the following chiefly deserve notice.

L. timidus, or the English hare. This animal is a native of almost every country of the old continent, and is generally of the length of two feet. Its upper lip is divided, and its eyes are extremely projected, and, it is said, kept open by it during sleep. It subsists on a great variety of vegetables, particularly those which possess milky qualities; the bark of young trees, and their tender shoots, are likewise often taken by them for food. It produces generally three young ones at a time, and breeds at least three times in a year. The hare seldom quits its seat, or form, as it is called, during the day, unless compelled by the approach of enemies; but takes its range for food and excursion by night, always returning, it is said, to her habitation by the same track by which it was left. In this form it will sometimes suffer itself to be approached so nearly, as to be nearly trodden upon before it starts for escape; the first advances of the enemy having probably not attracted its attention, and those which immediately followed, being attended by a species of fascination, or prostration of energy, the frequent effect of terror, till, at length, the imminence of its danger rouses every nerve and muscle, to exertions which enable it to leave its enemies at a considerable distance. Its fleetness is such, as to give it the advantage over many of its numerous adversaries. Its quickness of hearing, and comprehension of sight, by which last it receives the impressions of objects on almost every side, are also important means of its protection. The similarity of its co-

lour, likewise, to that of the ground, is another circumstance considerably in its favour. In the more northern regions, during the rigours of winter, its coat becomes of a perfect whiteness. By the particular structure of the hind-feet of this animal, it is qualified to run with rapidity up a considerable ascent, and seems to be conscious of this advantage, by frequently taking such a direction as gives it the full benefit of this peculiarity.

The average duration of the hare is about seven years; but so numerous are its enemies, that, notwithstanding the advantages above-mentioned, it very frequently fails to attain its natural term. It is pursued by dogs and foxes with mortal and unrelenting antipathy. Weasels, wild-cats, and wolves, seize and devour it whenever it is within their reach; and eagles, hawks, and other birds of prey, are also destructive enemies; but the most formidable of all is man, who finds one of the most interesting of his diversions in its persecution, and one of the highest luxuries of his table in its flesh. Indeed, so prolific is the hare, that without experiencing very considerable hostility, it would multiply to a most injurious degree; and in some districts of France, where the game was particularly and assiduously secured by the proprietors, no fewer than five hundred hares have been killed within a small compass in a single day.

The hare, if taken young, may be tamed and domestciated. It has occasionally been suckled and nursed by a cat. The celebrated Sonnini, the traveller and naturalist, had a hare in a complete state of domestication; and Cowper, the poet, was in possession of three, whose comforts he attended to with the most humane assiduity, and whose manners he has described with much interest and discrimination. The fur of the hare is of eminent, and almost indispensable utility, in the hat manufactory, and innumerable skins are annually brought to this country for that purpose from the north of Europe.

This animal was regarded by Moses as unclean, and unfit for food; it is considered in the same light also by the Mahometans. The Romans used to value it highly for the table. By the ancient Britons it was considered as partaking somewhat of a sacred character, which forbade their application of it to so ordinary a purpose. Hares have been seen in this country perfectly white, as in more northern regions, and accounts of horned hares have been given to the public upon unquestionable authority, though such animals are of extremely rare occurrence. For the Common Hare, see Mammalia, Plate XV. fig. 3.

L. variabilis, or the varying hare, is an inhabitant of the loftiest territories of the north, both of Europe and America. Its colour in summer is a tawny grey, and in winter it is changed to a perfect white. It never associates with the common hare, and rarely descends from its elevated haunts into the vallies; though occasionally, in a rigorous winter, numbers of these animals are seen to quit the frozen elevations of Siberia, and migrate for subsistence to the woody and sheltered plains.

L. cuniculus, or the rabbit, is found in most temperate climates, but not far to the north. Its fecundity is extreme, and in some countries has occasioned it to be considered as one of the greatest annoyances. It will breed, in favourable circumstances, seven times in a year, and produces about eight young ones at a time. It is most strikingly similar to the hare in general appearance; but while the hare prefers the uncovered field, the rabbit burrows in the ground. It has sharp and long claws for this purpose, and chooses dry and chalky soils, in which it can with the greatest ease construct its mansion. It lives to the age of about eight years. The female prepares a bed for its young before their birth, from its own coat, of the finest and warmest materials, nurses them with incessant assiduity, and is obliged often to secrete them from the malignant attempts of the male, which have been known, in many instances, to be fatal to them. In England, particularly in Cambridgeshire and Norfolk, rabbits are abundant, and their fur is of nearly equal value with their flesh.

The hare and rabbit never intermix, and appear to contemplate each other without the slightest sympathy. The principal difference between these two animals consists in the proportional length of the hind legs to that of the back. For the Rabbit, see Mammalia, Plate XV. fig. 4.

L. alpinus, or the Alpine hare, is about the size of a Guinea pig, is a native of the Altaic mountains, and burrows in the clefts of the rocks, or resides in the hollows of trees. These animals avoid the glare of day, and appear only by night, or in obscure and dull weather. They collect in summer a preparation of herbage, the most delicate and fragrant, and having dried it with the utmost care, set it aside in compact heaps for their subsistence

during winter. These heaps are occasionally of the height and depth of several feet, and are sometimes of extreme service to the horses of the sable hunters in those dreadful regions, preserving them from absolutely starving; a fate, however, to which the little labourers are exposed in consequence of these depredations.

L. pusillus, inhabits the south-east of Russia, is solitary, and rarely to be observed, even where most abundant. It is only about six inches in length. It generally indicates its residence by its sounds, resembling those of a quail. Its pace consists of a succession of leaps, rather than steps. It sleeps with its eyes open, is particularly gentle, passes but little of its time in sleep, and is perfectly familiarized in the course of two or three days after it is taken.

Lepus, in astronomy, a constellation of the southern hemisphere. See Astronomy.

LERCHEA, in botany, so named in honour of John Lerche; a genus of the Monadelphia Pentandria class and order. Essential character: calyx five-toothed; corolla funnel-form, five-cleft; anthers five, placed on the tube of the germ; style one; capsule three-celled, many-seeded. There is but one species, *viz.* L. longicauda, native of the East Indies.

LERNEA, in natural history, a genus of the Vermes Mollusca class and order. Body oblong, somewhat cylindrical, naked; two or three tentacula each side and round, by which it affixes itself; two ovaries, projecting like tails from the lower extremity. These insects are without eyes, and are said to be very troublesome to fish, adhering very firmly principally to the gills and fins. There are fifteen species. L. meridiana is one of the largest European species, often measuring an inch in length, and is a very common insect during the decline of summer, generally appearing in the hottest part of the day. It is brown above: brilliant tawny beneath; shining like satin.

LESKIA, in botany, so named from Nathaniel Godofr. Leske, Professor of Natural History and Oeconomy, in the University of Leipsic; a genus of the Cryptogamia Musci class and order. Natural order of Mosses. Generic character: capsule oblong; peristome double; the exterior with sixteen teeth, which are acute; the interior membranaceous, divided into equal segments. Males, gemmaceous in different individuals.

LETHARGY, in medicine, a disease wherein such a profound drowsiness or sleepiness attends the patient, that he can be scarce awaked, and if awaked, he remains stupid, without sense or memory, and presently sinks again into his former sleep.

LETTER, a character used to express one of the simple sounds of the voice; and as the different simple sounds are expressed by different letters, these by being differently compounded, become the visible signs or characters of all the modulations and mixtures of sounds used to express our ideas in a regular language. Thus, as by the help of speech we render our ideas audible, by the assistance of letters we render them visible, and by their help we can wrap up our thoughts, and send them to the most distant parts of the earth, and read the transactions of different ages. As to the first letters, what they were, who first invented them, and among what people they were first in use, there is still room to doubt: Philo attributes this great and noble invention to Abraham; Josephus, St. Irenæus, and others, to Enoch; Bibliander, to Adam; Eusebius, Clemens Alexandrinus, Cornelius Agrippa, and others, to Moses; Pomponius Mela, Herodian, Rufus Festus, Pliny, Lucan, &c. to the Phœnicians; St. Cyprian, to Saturn; Tacitus, to the Egyptians; some, to the Ethiopians; and others, to the Chinese: but, with respect to these last, they can never be entitled to this honour, since all their characters are the signs of words formed without the use of letters, which renders it impossible to read and write their language without a vast expense of time and trouble; and absolutely impossible to print it by the help of types, or any other manner but by the engraving, or cutting in wood. See Printing.

There have also been various conjectures about the different kinds of letters used in different languages; thus, according to Crinitus, Moses invented the Hebrew letters; Abraham, the Syriac and Chaldee; the Phœnicians, those of Attica, brought into Greece by Cadmus, and from thence into Italy by the Pelasgians; Nicostrata, the Roman; Isis, the Egyptian; and Vulfilas, those of the Goths.

It is probable that the Egyptian hieroglyphics were the first manner of writing: but whether Cadmus and the Phœnicians learned the use of letters from the Egyptians, or from their neighbours of Judea or Samaria, is a question; for since some of the books of the Old Testament were then written, they are more likely to have given them the hint than the hiero-

glyphics of Egypt. But wheresoever the Phœnicians learned this art, it is generally agreed, that Cadmus, the son of Agenor, first brought letters into Greece; whence, in the following ages, they spread over the rest of Europe.

Letters make the first part or elements of grammar; an assemblage of these compose syllables and words, and these compose sentences. The alphabet of every language consists of a number of letters, which ought each to have a different sound, figure, and use. As the difference of articulate sounds was intended to express the different ideas of the mind, so one letter was originally intended to signify only one sound, and not, as at present, to express sometimes one sound and sometimes another; which practice has brought a great deal of confusion into the languages, and rendered the learning of the modern tongues much more difficult than it would otherwise have been. This consideration, together with the deficiency of all the known alphabets, from their wanting some letters to express certain sounds, has occasioned several attempts towards an universal alphabet, to contain an enumeration of all such single sounds or letters as are used in any language. See Alphabet, and Writing, *origin of.*

Grammarians distinguish letters into vowels, consonants, mutes, liquids, diphthongs, and characteristics. They are also divided into labial, dental, guttural, and palatal, and into capital and small letters. They are also denominated from the shape and turn of the letters; and in writing are distinguished into different hands, as round-text, German-text, round hand, Italian, &c. and in printing, into roman, italic, and black letter. The term letter, or type, among printers, not only includes the capitals, small capitals, and small letters, but all the points, figures, and other marks, cast and used in printing; and also the large ornamental letters, cut in wood or metal, which take place of the illumined letters used in manuscripts. The letters used in printing are cast at the ends of small pieces of metal, about three quarters of an inch in length; and the letters being not indented, but raised, easily give the impression, when, after being blacked with a glutinous ink, paper is closely pressed upon it.

A fount of letters includes small letters, capitals, small capitals, points, figures, spaces, &c. but besides these, they have different kinds of two-lined letters, only used for titles, and the beginning of books, chapters, &c. See Fount.

LETTER *of attorney*, a writing authorising another to do any lawful act instead of the party himself, such as to sue and recover debts, to receive rents, seamen's wages, to execute leases, to give livery of seisin, &c. In all these cases the authority must be strictly pursued, and it is liable to be revoked by granting a new letter of attorney, or by death of either party. In cases of seamen, there are certain statute regulations for protecting them from imposition.

Letters *of marque*, are extraordinary commissions, granted to captains or merchants for reprisals, in order to make a reparation for those damages they have sustained, or the goods they have been deprived of by strangers at sea. These appear to be always joined to those of reprise for the reparation of a private injury; but under a declared war the former only are granted.

LEVATOR, in anatomy, a name given to several muscles. See Anatomy.

LEUCOIUM, in botany, *snow-drop*, a genus of the Hexandria Monogynia class and order. Natural order of Spathaceæ. Narcissi, Jussieu. Essential character: corolla bell-shaped, six-parted, thickened at the tips; stigma simple. There are four species: these are all bulbous rooted plants; the flowers, which at first sight resemble those of the common snow-drop, are easily distinguished by the absence of the three-leaved nectary, and they do not appear so soon by a month. These plants being of a different genus from the true snow-drop, ought certainly to have another English name: some botanists call it spring snow flake; others many-flowered bulbous violet. In the gardens it is known by the name of great summer snow-drop, and late or tall snow-drop. They are natives of the south of Europe.

LEUCOPHRA, in natural history, a genus of the Vermes Infusoria class and order: worm invisible to the naked eye, every where ciliate. There are eight species. L. cornuta: inversely conic, green, opaque. This is found in marshy grounds. Body broad, truncate on the fore part, with a small spine on each side; the hind part pellucid and pointed, sometimes it appears oval or kidney-shaped, and when the water which contains it evaporates, it breaks into molecular vesicles. L. nodulata; ovate-oblong, depressed, with a double row of tubercles. This species is found in the intestines of

lumbricus terristris, and nais littoralis: it is very pellucid, shining like silver, and is propagated by a transverse division; oval when young, and growing more oblong with age; truncate at the tip.

LEUCOPSIS, in natural history, a genus of insects of the order Hymenoptera: mouth horny, with short jaws, the mandible thick, and three toothed at the tip; lip longer than the jaw, membranaceous and emarginate at the tip; four feelers; short, equal, filiform; antennæ short, clavate; thorax with a long lanceolate scale beneath; wings folded; sting reflected, and concealed in a groove of the abdomen. There are four species.

LEVEL, an instrument constructed for the purpose of ascertaining the exact level of any fluid, building, &c. Of these there are two distinct kinds, *viz.* the horizontal and the perpendicular: the first sort, which comprises spirit and air levels, is chiefly in use among surveyors; the latter is ordinarily employed by artificers, and depends for exactness on a plumb line.

The instruments used by persons taking the levels of lands, waters, &c. whereby to ascertain the comparative heights of different spots, or tracts, are simple in the extreme, being generally made with a telescope of about fifteen inches long, fixed above a circular opening in a brass plate, so as to show a compass that traverses immediately below its centre, and gives not only the number of points, *i. e.* thirty-two, according to the mariner's division, but by means of a neat brass rim, graduated with three hundred and sixty degrees, divided into thirty-six portions of ten degrees each, and numbered, shows the exact angle made between any two sights taken by the telescope, which traverses on two legs, supported in grooves on the outer edge of the brass plate, and allowing it to move round in a direction perfectly parallel thereto. The plane thus described by the circular motion of the telescope is made to correspond with that of the horizon by the aid of a small brass tube, about six or eight inches in length, fixed exactly parallel with the line of sight through the telescope, and screwed to its cylinder in such manner as to remain firm. This little tube has on its upper side, or surface, an opening, into which a piece of clear glass, corresponding with the cylindrical curve of the tube, is fitted and properly cemented. This piece of glass being perfectly centrical, serves to show how the fluid, generally alcohol (or pure spirits), with which the tube is filled, with the exception of a very minute portion, stand in respect of inclination with, or from the horizon. When the bubble of air left in the tube floats exactly centrical in that portion which is covered with glass, the tube itself must be level; and as it is affixed at an exact parallel with the line of sight, which passes through the axis, or centre of the telescope, from the eye to the crossing of two hairs, at right angles, within the telescope, the instrument itself must then be level, and that part of any object, however distinct, which is cut or indicated by the line of sight, is ascertained by the centre of the cross made by the hairs being on a rectilinear level with the line of sight. But in consequence of the curvature of the earth's surface, the horizontal level will be different from the rectilinear level, and will describe an arc parallel with the surface of the earth. This curvature amounts to about eight inches in every mile; or, in more minute parts, may be taken at four and a half lines for every hundred yards.

The usual mode of taking a level is by means of a painted board, about a foot square, having a broad white stripe drawn horizontally across its centre. This board slides up and down a long pole, which being held perpendicularly by an assistant, at any appointed spot of which the level is to be ascertained, the instrument is brought to the exact direction in which the pole is situated; so that the latter may coincide, or as it is technically called, "be in one" with that basis which is vertical within the tube. The legs on which the level is supported, (generally the same as in theodolites, &c.) are spread so as to be firm; after bringing the compass as nearly as may be practicable to a level: by means of four screws, which serve to raise the different sides of the plate at pleasure, the utmost precision is attainable. The board is then moved up or down on the pole, which is marked all the way up in feet, inches, halves, and quarters, until the centre painted line "is in one" with the horizontal hair within the telescope. The height of the telescope above the surface on which it stands must be deducted from the number of feet and inches, at which the line on the board stands above the spot where the pole is fixed: the residue shows how much that is below the place where the instrument stands. But if the height of the line on the board be less than that at which the line of sight in the level stands from the ground, then the

difference between those two heights will exhibit how much the former is above the latter.

By this simple mode the level of any intended land, &c. may be correctly taken, observing to limit the sight as much as possible: indeed, it is always best to confine them to distances not exceeding three hundred yards; because the difference between the rectilinear and the horizontal levels are then greatly diminished, and the whole survey will prove far more correct. This will be easily seen from the following sketch. (Plate VIII. Miscellanies, fig. 2). Let A B represent a sight taken at 2100 yards, and let A C be an equal distance measured on the surface of the segment A D, but broken off at every three hundred yards, *i. e.* into seven portions: it must be obvious that the line B C will give a greater length than would result from the proportion already stated, the perpendicular falling so much beyond D; and that such difference would increase in its disproportions according as the range of sight might be enlarged. To prove this still more clearly, let us state that the quadrant O P (fig 3), of the earth's surface stands on a radius P S of four thousand miles. Now the first taken from the summit O of that quadrant would be a parallel to that horizontal radius, and a tangent to the arc at its summit, as from O to X. It is evident that if a sight of four thousand and one miles could be taken in the direction O X, a perpendicular falling from X would not even touch the point P, from which it would be a mile distant. It is true, that our sights are not to be compared with the foregoing extents; but it is equally true, that we verge towards the error above shown when we take too long sights.

Perhaps nothing can be more deceptive than the common mode of estimating levels: more than once we have witnessed the opinions of smatterers in this branch of surveying, who have levelled the instrument with great exactness, and directed the telescope to a very distant hill, on seeing the point of intersection cut near its summit, have concluded the spot so indicated to be on a level with that where the instrument stood. This misconception arises purely from a long rectilinear sight, without considering that the base of a remote hill is a plane, whose surface stands at a very great angle from that on which the level is placed; as shown by the dotted lines representing a hill R intercepted by the line of sight O X.

A very good kind of level is made on a portable plan, by several mechanics in this branch. It consists of a small tube of glass let into a plate with which it is exactly parallel. This is the surface, shewing the bubble in the tube, as before described: the under part of the box, which may be about eight inches long, two broad, and two deep, has a spring and screw that cause the box to change its direction from either above or below the horizon, to an exact rectilinear level, as indicated by the air left in the glass tube. At the centre of the bottom of the box is a brass stud, serving to fix into a hole made in the top of a walking-stick, &c. This kind of level, in the hands of a skilful surveyor, may be used to great advantage, where very great precision is not required; but as the sight is taken only from the upper edges of the box's ends, it does not admit of that great nicety which is indispensable in many operations, and where the smallest deviation from a true level might occasion immense expense and inconvenience.

The level represented in Plate Level, was made by the justly celebrated Jesse Ramsden, F. R. S. and considered by him as the most complete. It stands on three legs, which fold up into the size and appearance of a moderately thick round staff; three sliding rings, or leather bands, suffice to keep them compact and firm. The upper parts of the legs fit into a brass plate, as in theodolites, on the surface of which is a strong male screw, serving to fasten the working part of the instrument at pleasure, to its centre. The female screw is cut withinside a projection *b b* of a brass plate *a a*: this projection has a hole through its top, and contains a brass ball *d*, screwed into another similar plate *e e*; by which means the two plates are connected together, and the upper one can be turned about in any direction, while the lower one remains fixed. Four screws *n* passing through the lower plate, being worked in until they touch the bottom of the upper plate, serve either to fix the latter firmly; or, by unthreading one or two, and working in the opposite ones, to change the inclination of the upper plate, and to bring it to an exact level. These are called the parallel plates, though they often stand at an angle, the one with the other, when the direction of the upper one requires changing as above shown.

The ball *d* is perforated with a conical hole, to receive an axis *l*, that is screwed to the bottom of the compass box, *f*, on which are two square brass arms FC, pro-

jecting from it diametrically opposite to each other. H is a small brass angle, or frame, called a Y, screwed to the end of the arm C: it supports in its forked termination one end of the telescope K, of which the other end rests in a Y, (lettered N), similar to H, but which can be raised or lowered, by means of a screw having a milled head; as seen at *y*. The spirit level L is fixed to the telescope by two screws at its ends, whereby it can be brought into exact adjustment with the culmination of the telescope.

The level, which is the essential part of the instrument, has been already described; but it is proper to add, that the ends of the tube containing the alcohol, when made of glass, should be hermetically sealed at its ends, which should then be cased in brass. Mr. Ramsden preferred a very slight convexity in the tube; considering it best adapted for shewing the most trifling deviation from a perfect level, and causing the bubble to become more accurately centrical. With respect to the telescope, it is similar to those generally fitted to theodolites, &c. and has been described in the preceding part of this article. It is laid on in the two Y pieces, and kept in by two curved pieces of brass. In figure *h* is the achromatic object glass, fixed within the end of a tube, sliding within the external cylinder of the telescope, and moved very gradually by a rack and pinion on the mill-headed nut *i*: the distance of the glass *h* from the eye-piece, is thereby adjusted to a suitable focus.

The eye-piece K contains two lenses, sliding in a tube fixed to the telescope, for adjusting them to a distinct vision of the cross wires, or hairs, which are held in a proper state of tension in the frame *t*, and regulated to the axis, or line of sight, by four minute screws passing through the outside of the telescope.

We have before shown how the four screws act upon the two parallel plates, *a a* and *e e*, while the axis *b* can be set very nearly perpendicular; then by the screw *y* the telescope can be set very nearly level. To turn the telescope about horizontally upon its axis *l*, a screw *m* works in a fixed collar *v*; its nut *p* is fastened upon an arm which projects from a clamp *g*, embracing a collar upon the axis *l*, and is tightened by a screw *r*; which being unscrewed, the clamp springs open, and the telescope, together with the level, moves round with freedom upon the axis *l*, according to the pleasure of the operator. When the screw *r* is tightened, the clamp holds the telescope fast, but admits of a slight movement, either way, when acted upon by the mill-headed screw *m*.

Our readers will readily perceive the simplicity of this level, beyond any others in use; and will lament the demise of a gentleman, who, to profound theory, added the most ingenious and skilful practice.

Where a very long and continued range of brickwork is to be raised, it is often advisable to use a water level, made by laying a ridge of mortar along the centre of the wall, and opening a very narrow channel throughout its centre longitudinally, so as to form a kind of trough; let the ends be stopped, and the trough be filled with water, as far as it will flow. The surface of the water will give a true horizontal level; which, if continued for miles, would conform exactly to the curvature of our globe. To continue the level along the rest of the trough, stop it at the place where the water reached, and raising the adjacent part with more mortar, let the trough of the superior level be filled, and thus in succession. The difference between the end of one trough, and the beginning of another, will shew the respective levels; from which parallels may be set off at any height above by plumb lines of equal length. This mode is often practised in large works, such as fortifications, and when strata of masonry are to be regularly disposed; also to prevent those irregular breaks, and partial connexions, that are almost inevitable where small sallows, or triangular levels, with plumb weights, are in use.

When no instrument can be obtained, and where it is not easy to draw an exact level by the foregoing means, take the hose of an engine, and having fixed one end at the spot whose level is to be sought, (on any opposite bank, for instance,) carry the other end to the place where the corresponding height is to be established. Fill the hose with water until it ceases to require raising at the further end. When both ends show full to the brim, and that the water is retained at both, then they are on the same level: for it is a maxim in Hydrostatics (which see), that water, or, indeed, any fluid heavier than atmospheric air, will, when at liberty, always find its own level.

Where a succession of contiguous levels are wanted, it will often be found convenient to use a small leaden pipe, of about half an inch bore, which should be applied as above described; or even a common gutter, made of two pieces of

planks, like those under the eaves of houses, may be made to answer the purpose, by supporting either end, until the water may come to a level in every part.

Where works of moderate extent are carried on, and where the perfect level of each stratum of materials is not an object of importance, the common bricklayer's level, made in the form of an inverted T, thus ⊥, having a plumb suspended from the top, and received in an opening at the junction of the perpendicular with the horizontal piece, will answer well enough. The principle on which this acts, is, that as all weights have a tendency to gravitate towards the centre of the earth, so as the plumb line is a true perpendicular, any line, cutting that at right angles, must be a horizontal line at the point of intersection.

Level, *artillery-foot*, is in form of a square, having its two legs or branches of an equal length, at a juncture whereof is a little hole, whence hangs a thread and plummet, playing on a perpendicular line in the middle of a quadrant. It is divided into twice forty-five degrees from the middle.

This instrument may be used on other occasions, by placing the ends of its two branches on a plane; for when the thread plays perpendicularly over the middle division of the quadrant, that plane is assuredly level. To use it in gunnery, place the two ends on the piece of artillery, which you may raise to any proposed height, by means of the plummet, whose thread will give the degree above the level.

Level, *carpenter's and paviour's*, consists of a long ruler, in the middle whereof is fitted, at right angles, another somewhat bigger, at the top of which is fastened a line, which, when it hangs over a fiducial line at right angles with the base, shows that the said base is horizontal. Sometimes this level is all of one board.

Level, *gunner's*, for levelling cannons and mortars, consists of a triangular brass plate, about four inches high, at the bottom of which is a portion of a circle, divided into forty-five degrees, which number is sufficient for the highest elevation of cannons and mortars, and for giving shot the greatest range: on the centre of this segment of a circle is screwed a piece of brass, by means of which it may be fixed or screwed at pleasure; the end of this piece of brass is made so as to serve for a plummet and index, in order to show the different degrees of elevation of pieces of artillery. This instrument has also a brass foot, to set upon cannons or mortars, so as when those pieces are horizontal, the instrument will be perpendicular. The foot of this instrument is to be placed on the piece to be elevated, in such a manner as that the point of the plummet may fall on the proper degree: this is what they call levelling the piece.

Level, *mason's*, is composed of three rules, so joined as to form an isosceles-triangle, somewhat like a Roman A, at the vertex whereof is fastened a thread, from which hangs a plummet, that passes over a fiducial line, marked in the middle of the base, when the thing, to which the level is applied, is horizontal; but declines from the mark, when the thing is lower on one side than on the other.

Level, *plumb* or *pendulum*, that which shews the horizontal line by means of another line perpendicular to that described by a plummet or pendulum. This instrument consists of two legs or branches, joined together at right angles, whereof that which carries the thread and plummet is about a foot and a half long; the thread is hung towards the top of the branch. The middle of the branch where the thread passes is hollow, so that it may hang free every where: but towards the bottom, where there is a little blade of silver, whereon is drawn a line perpendicular to the telescope, the said cavity is covered by two pieces of brass, making as it were a kind of case, lest the wind should agitate the thread; for which reason the silver blade is covered with a glass to the end, that it may be seen when the thread and plummet play upon the perpendicular. The telescope is fastened to the other branch of the instrument, and is about two feet long; having an hair placed horizontally across the focus of the object-glass, which determines the point of the level. The telescope must be fitted at right angles to the perpendicular. It has a ball and socket, by which it is fastened to the foot.

LEVELLING. See Level.

Levelling *staves*, instruments used in levelling, serving to carry the marks to be observed, and at the same time to measure the heights of those marks from the ground. They usually consist each of two long wooden rollers, made to slide over one another, and divide into feet, inches, &c.

LEVER, in mechanics, an inflexible right line, rod, or beam, supported in a single point on a fulcrum or prop, and used for the raising of weights; being either void of weight itself, or at least having such a weight as may be commodiously counterbalanced.

The lever is the first of those called mechanical powers, or simple machines, as being of all others the most simple; and is chiefly applied for raising weights to small heights. See MECHANICS.

LEVISANUS, in botany, so called from the Rev. Mr. Lewis, a genus of the Pentandria Monogynia class and order. Essential character: flowers aggregate; calyx one-leafed, superior, five-cleft; corolla five petalled, superior; filaments inserted into the base of the perianth; styles two, conjoined; berry two celled; seeds five or six, compressed. There are five species, which are all shrubs, and natives of the Cape of Good Hope.

LEYSERA, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx scariose; down chaffy; in the disk feathery also; receptacle subpaleaceous. There are three species.

LEY, or *lees*, a term usually applied to any alkaline solution, made by levigating any ashes that contain an alkali. Soap-lees is an alkali used by soap-boilers, or potash or soda in solution, and made caustic by lime. Lees of wine are the refuse, or sediment, that deposits from wine by standing quiet.

LEYDEN *phial*, in electricity, is a glass phial or jar, coated both within and without with tin foil, or other conducting substance, that it may be charged, and employed in a variety of experiments. Flat glass, or glass of any shape, may be used in the same way.

LIATRIS, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx oblong, imbricate, awnless, coloured; down feathered, coloured; receptacle naked, hollow, dotted. There are eight species.

LIBELLULA, in natural history, *dragon-fly*, a genus of insects of the order Neuroptera. Mouth armed with jaws, more than two in number; lip trifid; antennæ very thin, filiform, and shorter than the thorax; wings expanded; tail of the male insect furnished with a forked process. There are about sixty species, divided into two families. A. wings expanded when at rest. B. wings erect when at rest; eyes distinct; outer divisions of the lip bifid. The whole tribe of the libellula are remarkable for being ravenous: they are usually to be seen hovering over stagnant waters, and may, in the middle of the day, be observed flying with great rapidity in pursuit of the smaller insects. These brilliant and beautiful animals were once, and for a considerable time, inhabitants of the water: in that state, as larva, they are six-footed, active, and furnished with an articulate forcipated mouth. They prey upon aquatic insects, and the larva of others: the pupa resembles the larva, but has the rudiments of wings. The most remarkable of the English species is the L. varia, or great variegated libellula, which makes its appearance towards the decline of summer, and is an animal of singular beauty. Its length is about three inches; and the wings, when expanded, measure nearly four inches from tip to tip. The female libellula drops her eggs in the water, which, on account of their specific gravity, sink to the bottom: after a certain period they are hatched into larvæ, having a singular and disagreeable aspect: they cast their skins several times before they arrive at their full size, and are of a dusky brown colour: the rudiments of the future wings appear on the back of such as are advanced to the pupa state in the form of oblong scales, and the head is armed with a singular organ for seizing its prey. They continue in the larva and pupa state two years; when, having attained to their full size, they prepare for their ultimate change, and creeping up the stem of some water plant, and grasping it with their feet, they make an effort, by which the skin of the back and head is forced open, and the enclosed libellula gradually emerges. This process takes place in a morning, and during a bright sunshine. The remainder of the animal's life is short, the frosts of autumn destroying them all. "It is impossible," says Dr. Shaw, "not to be struck with admiration on contemplating the changes of the libellula, which, while an inhabitant of the water, would perish by any long exposure to the air, while the complete animal, once escaped from the pupa, would as effectually be destroyed by submersion under water, of which not an hour before it was the legitimate inhabitant." In this, and other species of the libellula tribe, the structure of the eye is deserving of notice. A common magni-

fier, of an inch focus, shows, that the cornea is marked by a prodigious number of minute decussating lines, giving a kind of granular appearance to the whole convexity; but with a microscope it exhibits a continued surface of convex hexagons. According to Lewenhoek there are 12,544 lenses in each eye of this animal. See Shaw's Zoology, vol. vi.

LIBELLUS *famosus.* A contumely or reproach, published to the defamation of the government, of a magistrate, or of a private person. It is also defined to be a malicious defamation, expressed either in printing or writing, or by signs, pictures, &c. tending either to blacken the memory of one who is dead, or the reputation of one who is alive, and thereby exposing him to public hatred, contempt, and ridicule.

Libels, says Blackstone, taken in their largest and most extensive sense, signify any writings, pictures, or the like, of an immoral or illegal tendency. This species of defamation is usually termed written scandal, and thereby receives an aggravation, in that it is presumed to have been entered upon with coolness and deliberation; and to continue longer, and propagate wider and further than any other scandal.

The important distinction between libels and words spoken, was fully established in the case of Villers v. Mousley, (2 Wils. 403.) *viz.* that whatever renders a man ridiculous, or lowers him in the esteem and opinion of the world, amounts to a libel; though the same expressions, if spoken, would not have been defamation: as, to call a person, in writing, an itchy old toad, was held in that case to be a libel; although, as words spoken, they would not have been actionable. And on this ground, a young lady of quality, in the year 1793, recovered 4,000*l.* damages for reflections upon her chastity, published in a newspaper, although she could have brought no action for the grossest verbal aspersions that could have been uttered against her honour. An action for a libel also differs from an action for words in this particular; that the former may be brought at any time within six years, and any damages will entitle the plaintiff to full costs. To print of any person that he is a swindler, is a libel, and actionable.

All libels are made against private men, or magistrates, and public persons; and those against magistrates deserve the greatest punishment: if a libel be made against a private man, it may excite the person libelled, or his friends, to revenge and to break the peace; and if against a magistrate, it is not only a breach of the peace, but a scandal to government, and stirs up sedition.

Where a writing inveighs against mankind in general, or against a particular order of men, this is no libel; it must descend to particulars and individuals, to make it a libel. But a general reflection on the government is a libel, though no particular person is reflected on: and the writing against a known law is held to be criminal.

Though a private person or magistrate be dead at the time of making the libel, yet it is punishable, as it tends to a breach of the peace. But an indictment for publishing libellous matter reflecting on the the memory of a dead person, not alleging that it was done with a design to bring contempt on the family of the deceased, and to stir up the hatred of the King's subjects against them, and to excite his relations to a breach of the peace, cannot be supported; and judgment was in this case accordingly arrested.

Scandalous matter, in legal proceedings, by bill, petition, &c. in a court of justice, amounts not to a libel, if the court hath jurisdiction of the cause. But he who delivers a paper full of reflections on any person, in nature of a petition to a committee, to any other persons except the members of parliament who have to do with it, may be punished as the publisher of a libel. And by the better opinion, a person cannot justify the printing any papers which import a crime in another, to instruct counsel, &c. but it will be a libel. 2. The communication of a libel to any one person, is a publication in the eye of the law; therefore the sending an abusive private letter to a man, is as much a libel as if it were openly printed; for it equally tends to a breach of the peace.

In the making of libels, if one man dictates, and another writes a libel, both are guilty: for the writing after another shows his approbation of what is contained in the libel; and the first reducing a libel into writing may be said to be the making it, but not the composing. If one repeats, another writes, and a third approves what is written, they are all makers of the libel; because all persons who concur to an unlawful act are guilty.

If one writes a copy of a libel and does not deliver it to others, the writing is no publication: but it has been adjudged that the copying of a libel, without authority, is writing a libel, and he that thus writes it is a contriver; and that he who

hath a written copy of a known libel, if it is found upon him, this shall be evidence of the publication; but if such libel be not publicly known, then the mere having a copy is not a publication.

When any man finds a libel, if it be against a private person, he ought to burn it, or deliver it to a magistrate; and where it concerns a magistrate, he should deliver it presently to a magistrate.

The sale of the libel by a servant in a shop, is prima facie evidence of publication, in a prosecution against the master; and is sufficient for conviction, unless contradicted by contrary evidence, shewing that he was not privy, nor in any way assenting to it.

It is immaterial, on a criminal prosecution with respect to the essence of a libel, whether the matter of it be true or false; because it equally tends to a breach of the peace; and the provocation, not the falsity, is the thing to be punished criminally; though, doubtless, the falsehood of it may aggravate its guilt and enhance its punishment. In a civil action, a libel must appear to be false as well as scandalous: for if the charge be true, the plaintiff has received no private injury, and has no ground to demand for a compensation himself, whatever offence it may be against the public peace; and, therefore, upon a civil action, the truth of the accusation may be pleaded in bar of the suit. But in a criminal prosecution, the tendency which all libels have to create animosities, and to disturb the public peace, is the whole that the law considers. And, therefore, in such prosecutions, the only points to be enquired into are, first, the making or publishing of a book or writing; and, secondly, whether the matter be criminal; and if both these points are against the defendant, the offence against the public is complete.

It is not competent to a defendant charged with having published a libel, to prove that a paper, similar to that for the publication of which he is prosecuted, was published on a former occasion by other persons who have never been prosecuted for it.

The punishment of libellers for either making, repeating, printing, or publishing the libel, is fine, and such corporal punishment (as imprisonment, pillory, &c.) as the court in its discretion shall inflict; regarding the quantity of the offence, and the quality of the offender. Also, if booksellers, &c. publish or sell libels, though they know not the contents of them, they are punishable.

It has been held that writing a seditious libel is not an actual breach of the peace: and that a member of parliament writing such a libel is entitled to his privilege from being arrested for the same.

In informations, the libel must be set out correctly, according to the words or the material sense.

It has been frequently determined, that in the trial of an indictment for a libel, the only questions for the consideration of the jury are, the fact of publishing, and the truth of the innuendoes; that is, the truth of the meaning, and sense of the passages of the libel, as stated and averred in the record; whether the matter be or be not a libel, is a question of law for the consideration of the court. But the statute 32 Geo. III. c. 60, after reciting that "doubts had arisen whether on the trial of an indictment or information for the making or publishing any libel, where an issue or issues are joined between the King and the defendant on the plea of not guilty pleaded, it be competent to the jury, impannelled to try the same, to give their verdict upon the whole matter in issue," enacts, that "on every such trial, the jury, sworn to try the issue, may give a general verdict of guilty or not guilty, upon the whole matter put in issue, upon such indictment or information; and shall not be required or directed by the court or judge, before whom the indictment, &c. shall be tried, to find the defendant guilty, merely on the proof of the publication by such defendant, of the paper charged to be a libel, and of the sense ascribed to the same in such indictment." But it is provided by the said statute, that the court or judge shall, according to their discretion, give their opinion and directions to the jury on the matter in issue, as in other criminal cases, that the jury may also find a special verdict; and that, in case the jury shall find the defendant guilty, he may move in arrest of judgment, as by law he might have done before the passing of the act.

It has, in the case of the King *v.* Lord George Gordon; and the King *v.* Peltier, been held, that a writing tending to defame the Sovereign of a foreign country, is a libel punishable in England. The law was not questioned in the first case; in the second the punishment was not enforced. We think there are many serious arguments against the doctrine.

In the case of Gilbert Wakefield, and of Hart and White, recently, although the offences were committed, and the

trials had in Westminster and London, the defendants were committed to Dorchester and Gloucester gaols, to render their confinement the more irksome and severe.

We have thus briefly endeavoured to select the principal authorities under the law of England, with respect to libels, and we are free to confess, that unless juries boldly assert the right of judging according to the general intention and honest view of the writer, rather than upon casual expressions, and the subtle innuendoes of an information, there will be found little actual liberty of the press, excepting what is allowed by the lenity of an attorney general.

For the law is strictly, that any thing which affects the character of an individual, or reflects on the government, is a libel; and with such a restraint we hold the right of free discussion upon a frail tenure. The absolute freedom of the press can, we think, never be fully obtained while truth continues to be a libel; and it is remarkable, that in former times, libels were charged as false, scandalous, and malicious writings; in the time of Lord Coke, the doctrine was laid down, that the falsehood of a libel was immaterial; and very recently, the word "false," has been omitted in the informations filed by the present Attorney General, Sir Vicary Gibbs.

We admit that the point, how far the press shall be uncontrolled, is a nice question in politics; but it should be remembered that the press, that is, the right of public complaint, and of exposing public delinquents to public odium, is the people's cheapest and best defence, and the oppressors' greatest awe. Were that right uncontrolled, no wicked government could last long; and as the press is open to all, perhaps no just and good government could long continue to be misrepresented before an enlightened and just thinking people. In England, it must be acknowledged, that the practical liberty of the press has been greater than in any country in the world; but we attribute this more to the character of the government and the people, than to the law, which, if rigidly exercised, would be severe. We have, it is true, not had very frequently informations for libels at the suit of government, but we have never known them fail to convict, except in the case of Mr. Reeves, for a libel on the House of Commons, which was prosecuted by the popular party.

We shall observe, that the law of libels is plainly derived to us from the imperial constitutions of Rome under the Constantines, not from the laws of republican Rome, and that it came recommended to us from the Star Chamber by Lord Coke. We have not here sufficient space to investigate, as a political question, what ought to be the law of libels; and we must acknowledge, that many objections may occur to admitting truth to be a justification of a writing, when it is aimed at government, and there is great difficulty in verifying charges of misconduct, even when they are confined to particular instances. It is only by long reflection, and an ardent desire for the utmost liberty that is consistent with good government, that we are led to wish that the press should be uncontrolled.

Libel, in the spiritual court, the original declaration of any action in the civil law. See statute 2 Edward VI. c. 13.

The libel used in ecclesiastical proceedings consists of three parts: 1. The major proposition, which shows a just cause of the petition. 2. The narration, or minor proposition. 3. The conclusion, or conclusive petition, which conjoins both propositions, &c.

LIBERTY, in its most general signification, is said to be a power to do as one thinks fit; unless restrained by the law of the land: and it is well observed, that human nature is ever an advocate for this liberty; it being the gift of God to man in his creation. It is upon that account the laws of England in all cases favour liberty. According to Montesquieu, liberty consists principally in not being compelled to do any thing which the law does not require; because we are governed by civil laws, and therefore we are free, living under those laws.

The absolute rights of man, considered as a free agent, endowed with discernment to know good from evil, and with power of choosing those measures which appear to him to be most desirable, are usually summed up in one general appellation, and denominated the natural liberty of mankind. This natural liberty consists properly in a power of acting as one thinks fit, without any restraint or control, unless by the law of nature; being a right inherent in us by birth, and one of the gifts of God to man at his creation, when he endowed him with the faculty of free will.

But every man, when he enters into society, gives up a part of his natural liberty, as the price of so valuable a purchase; and in consideration of receiving the advantages of mutual commerce, obliges himself to conform to those laws which

the community has thought proper to establish. This species of legal obedience is infinitely more desirable than that wild and savage liberty, which is sacrificed to obtain it. For no man, who considers a moment, would wish to retain the absolute and uncontrolled power of doing whatever he pleases; the consequence of which is, that every other man would also have the same power; and then there would be no security to individuals in any of the enjoyments of life.

Political or civil liberty, therefore, which is that of a member of society, is no other than natural liberty, so far restrained by human laws, and no further, as is necessary and expedient for the general advantage of the public.

Hence we may collect that the law, which restrains a man from doing mischief to his fellow-citizens, though it diminishes the natural, increases the civil liberty of mankind: but that every wanton and causeless restraint of the will of the subject, whether practised by a monarch, by nobility, or a popular assembly, is a degree of tyranny; nay, that even laws themselves, whether made with or without our consent, if they regulate and constrain our conduct in matters of mere indifference, without any good end in view, are regulations destructive of liberty; whereas, if any public advantage can arise from observing such precepts, the control of our private inclinations, in one or two particular points, will conduce to preserve our general freedom in others of more importance, by supporting that state of society which alone can secure our independence. So that laws, when prudently framed, are by no means subversive, but rather introductive of liberty; for where there is no law, there is no freedom.

But then, on the other hand, that constitution, or form of government, is alone calculated to maintain civil liberty, which leaves the subject entire master of his own conduct, except in those points wherein the public good requires some direction or restraint.

The above definition of the learned commentator is admitted by his last editor to be clear, distinct, and rational, as far as relates to civil liberty; in the definition of which, however, he adds, it ought to be understood, or rather expressed, that the restraints introduced by the law should be equal to all; in as much so as the nature of things will admit.

Political liberty is distinguished by Mr. Christian from civil liberty, and he defines it to be the security with which, from the constitution, form, and nature of the established government, the subjects enjoy civil liberty. No ideas, continues he, are more distinct than those of civil and political liberty; yet they are generally confounded; and the latter cannot yet claim an appropriate name. The learned judge (Blackstone) uses political and civil liberty indiscriminately; but it would perhaps be convenient uniformly to use those terms in the respective senses here suggested, or to have some fixed specific denominations for ideas, which, in their natures, are so widely different. The last species of liberty has most engaged the attention of mankind, and particularly of the people of England.

The people of England have a firm reliance that this civil liberty is secured to them under the constitution of the government.

First. By the great charter of liberties, which was obtained, sword in hand, from King John; and afterwards, with some alterations, confirmed in parliament by King Henry III. his son; which charter contained very few new grants; but, as Sir Edward Coke observes, was for the most part declaratory of the principal grounds of the fundamental laws of England. Afterwards, by the statute called *Confirmatio Cartarum*, 25 Edward I. whereby the great charter is directed to be allowed as the common law: all judgments contrary to it are declared void; copies of it are ordered to be sent to all the cathedral churches, and read twice a year to the people; and sentence of excommunication is directed to be as constantly denounced against all those who, by word, deed, or counsel, act contrary thereto, or in any degree infringe it. Next, by a multitude of subsequent corroborating statutes from Edward I. to Henry IV.; of which the following are the most forcible.

Statute 25 Edward III. statute 5, c. 4. None shall be taken by petition or suggestion made to the King or his council, unless it be by indictment of lawful people of the neighbourhood, or by process made by writ original at the common law. And none shall be put out of his franchises or freehold, unless he be duly brought to answer, and fore-judged by course of law; and if any thing be done to the contrary, it shall be redressed and holden for none.

Statute 42 Edward III. c. 3. No man shall be put to answer without presentment before justices, or matter of record of due process, or writ original, according to the ancient law of the land. And

if any thing be done to the contrary, it shall be void in law, and held for error. After a long interval these liberties were still further confirmed by the petition of right; which was a parliamentary declaration of the liberties of the people, assented to by King Charles I. in the beginning of his reign. This was closely followed by the still more ample concessions made by that unhappy Prince to his parliament; (particularly the dissolution of the Star Chamber, by statute 16 Charles I. c. 10); before the fatal rupture between them; and by the many salutary laws, particularly the Habeas Corpus Act, passed under King Charles II.

To these succeeded the Bill of Rights, or declaration delivered by the Lords and Commons to the Prince and Princess of Orange, February 13, 1688; and afterwards enacted in parliament, when they became King and Queen; which, as peculiarly interesting, is here inserted at length.

Statute 1 William and Mary, statute 2, c. 2, § 1. Whereas the Lords Spiritual and Temporal, and Commons, assembled at Westminster, representing all the estates of the people of this realm, did, upon the 13th of February 1688, present unto their Majesties, then Prince and Princess of Orange, a declaration, containing, that the said Lords Spiritual and Temporal, and Commons, being assembled in a full and free representative of this nation, for the vindicating their ancient rights and liberties, declare, that the pretended power of suspending of laws, or the execution of laws, by legal authority, without consent of parliament, is illegal; that the pretended power of dispensing with laws, or the execution of laws, by regal authority, as it hath been assumed and exercised of late, is illegal; that the commission for erecting the late court of commissioners for ecclesiastical causes, and all other commissions and courts of like nature, are illegal and pernicious.

That levying money for, or to the use of the crown, by pretence of prerogative, without grant of parliament, for longer time, or in other manner than the same is or shall be granted, is illegal; that it is the right of the subjects to petition the King, and all commitments and prosecutions for such petitioning, are illegal; that the raising or keeping a standing army within the kingdom in time of peace, unless it be with consent of parliament, is against law; that the subjects which are protestants may have arms for their defence, suitable to their conditions, and as allowed by law; that election of members of parliament ought to be free; that the freedom of speech, and debates or proceedings in parliament ought not to be impeached or questioned in any court or place out of parliament; that excessive bail ought not to be required, nor excessive fines imposed, nor cruel and unusual punishments inflicted; that jurors ought to be duly impannelled and returned, and jurors which pass upon men in trials for high treason, ought to be freeholders; that all grants and promises of fines and forfeitures of particular persons before conviction, are illegal and void; and for redress of all grievances, and for the amending, strengthening, and preserving of the laws, parliaments ought to be held frequently; and they do claim, demand, and insist upon all and singular the premises, as their undoubted rights and liberties; and that no declarations, judgments, doings, or proceedings, to the prejudice of the people in any of the said premises, ought in anywise to be drawn hereafter into consequence or example; Sect. 6. All and singular the rights and liberties asserted and claimed in the said declaration are the true, ancient, and indubitable rights and liberties of the people of this kingdom, and so shall be esteemed, allowed, adjudged, and taken to be; and all the particulars aforesaid shall be firmly holden as they are expressed in the said declaration; and all officers shall serve their majesties according to the same in all times to come. Sect. 12. No dispensation by *non obstante* of any statute shall be allowed, except a dispensation be allowed of in such statute; and except in such cases as shall be especially provided for during session of parliament. Sect. 13. No charter granted before the 23d of October 1689, shall be invalidated by this act, but shall remain of the same force as if this act had never been made. Lastly, these liberties were again asserted at the commencement of the present century, in the Act of Settlement, statute 12 and 13 William III. c. 2, whereby the crown was limited to his present Majesty's illustrious house; and some new provisions were added at the same fortunate æra, for better securing our religion, laws, and liberties, which the statute declares to be "the birthright of the people of England;" according to the ancient doctrine of the common law.

Thus much for the declaration of our rights and liberties. The rights themselves, thus defined by these several statutes,

consist in a number of private immunities, which will appear, from what has been premised, to be indeed no other than either that residuum of natural liberty, which is not required by the laws of society to be sacrificed to public convenience, or else those civil privileges, which society hath engaged to provide in lieu of the natural liberties so given up by individuals. These, therefore, were formerly, either by inheritance or purchase, the rights of all mankind; but in most other countries of the world, being now more or less debased or destroyed, they at present may be said to remain, in a peculiar and emphatical manner, the rights of the people of England.

These rights may be reduced to three principal or primary articles:

The right of personal security. The right of personal liberty. The right of private property.

The right of personal security consists in a person's legal and uninterrupted enjoyment of his life, his limbs, his body, his health, and his reputation. The enjoyment of this right is secured to every subject by the various laws made for the punishment of those injuries, by which it is any way violated; for a particular detail of which, see Assault, Homicide, Maihem, Libel, Nuisance, &c.

The words of the Great Charter, c. 29, are, "Nullus liber homo capiatur, imprisonetur, vel aliquo modo destruatur, nisi per legale judicium parium suorum aut per legem terræ." No freeman shall be taken, imprisoned, or any way destroyed, unless by the lawful judgment of his peers, or by the law of the land; which words, "aliquo modo destruatur," according to Coke, include a prohibition, not only of killing or maiming, but also of torturing, (to which our laws are strangers), and of every oppression by colour of an illegal authority. And it is enacted by stat. 5 Edward III. c. 9, that no man shall be attached by any accusation, nor forejudged of life or limb, nor shall his lands or goods be seized into the King's hands contrary to the Great Charter, and the law of the land. And again, by statute 28 Edward III. c. 3, that no man shall be put to death without being brought to answer by due process of law.

The right of personal liberty consists in the power of loco-motion, of changing situation, or moving one's person to whatsoever place one's own inclination may direct, without imprisonment or restraint, unless by due course of law. This right there is at present no occasion to enlarge upon. For the provisions made by the laws of England to secure it, see Habeas *corpus*, False *imprisonment*, Bail, Arrest, &c.

The absolute right of property, inherent in every Englishman, consists in the free use, enjoyment, and disposal of all his acquisitions, without any controul or diminution, save only by the laws of the land.

Another effect of this right of private property is, that no subject of England can be constrained to pay any aids or taxes, even for the defence of the realm, or the support of the government, but such as are imposed by his own consent, or that of his representatives in parliament. By statute 25 Edward I. c. 5, 6, it is provided, that the King shall not take any aids, or tasks, but by the common assent of the realm. And what that common assent is, is more fully explained by statute 34 Edward I. statute 4, c. 1; which enacts, that no talliage or aid shall be taken, without the assent of the Archbishops, Bishops, Earls, Barons, Knights, Burgesses, and other freemen of the land: and again, by statute 14 Edw. III. statute 2, c. 1, the Prelates, Earls, Barons, and Commons, Citizens, Burgesses, and Merchants, shall not be charged to make any aid, if it be not by the common assent of the great men and commons in parliament. And as this fundamental law had been shamefully evaded, under many preceding princes, by compulsive loans and benevolences, extorted without a real and voluntary consent, it was made an article in the petition of right, 3 Charles I. that no man shall be compelled to yield any gift, loan, or benevolence, tax, or such like charge, without common consent by act of parliament. And, lastly, by the Bill of Rights, statute 1 William and Mary, statute 2, c. 2, it is declared, that levying money for or to the use of the crown, by pretence of prerogative, without grant of parliament, or for longer time, or in other manner than the same is or shall be granted, is illegal.

The above is a short view of the principal absolute rights which appertain to every Englishman: and the constitution has provided for the security of their actual enjoyment, by establishing certain other auxiliary, subordinate rights, which serve principally as out-works or barriers to protect and maintain those principal rights inviolate. These are,

The constitution, powers, and privileges of parliament. The limitation of the King's prerogative. The right of applying to courts of justice for redress of

injuries. The right of petitioning the King or parliament. The right of having arms for defence.

This last auxiliary right of the subjects of having arms for their defence, suitable to their condition and degree, and such as are allowed by law, is declared by the Bill of Rights; and it is, indeed, a public allowance, under due restrictions of the natural right of resistance and self-preservation, when the sanctions of society and laws are found insufficient to restrain the violence of oppression.

As to the first and second of the subordinate rights above-mentioned, see PARLIAMENT, KING.

With respect to the third and fourth, some short information is here subjoined.

Since the law is, in England, the supreme arbiter of every man's life, liberty, and property, courts of justice must at all times be open to the subject, and the law be duly administered therein. The emphatical words of Magna Charta, c. 29, spoken in the person of the King, who, in judgment of law (says Sir Edward Coke) is ever present, and repeating them in all his courts, are these, "Nulli vendemus, nulli negabimus, aut differemus, rectum vel justitiam." To none will we sell, to none will we deny, or delay, right or justice.

It is also ordained by Magna Charta, c. 29, that no freeman shall be outlawed, that is, put out of the protection and benefit of the law, but according to the laws of the land. By statutes 2 Edward III. c. 8. 11 Richard II. c. 10, it is enacted, that no commands or letters shall be sent under the Great Seal, or the Little Seal, the Signet or Privy Seal, in disturbance of the law; or to disturb or delay common right, and though such commandments should come, the judges shall not cease to do right. This is also made a part of their oath, by statute 11 Edward III. stat. 4. And by the Bill of Rights it is declared, that the pretended power of suspending or dispensing with laws, or the execution of laws, by regal authority, without consent of parliament, is illegal. Not only the substantial part, or judicial decisions of the law, but also the formal part, or method of proceeding, cannot be altered but by parliament; for, if once those outworks were demolished, there would be an inlet to all manner of innovation in the body of the law itself. The King, it is true, may erect new courts of justice; but then they must proceed according to the old established forms of the common law. For which reason it is declared in the statute, 16 Charles I. c. 10, upon the dissolution of the court of star-chamber, that neither his Majesty nor his Privy Council have any jurisdiction, power, or authority, by English bill, petition, articles, or libel, (which were the course of proceeding in the Star-Chamber borrowed from the civil law), or by any other arbitrary way whatsoever, to examine or draw into question, determine or dispose of the lands or goods of any subjects of this kingdom; but that the same ought to be tried and determined in the ordinary courts of justice, and by course of law.

The right of petitioning the King, or either house of parliament, for the redress of grievances appertains to every individual in cases of any uncommon injury, or infringement of the rights already particularized, which the ordinary course of law is too defective to reach. The restrictions, for some there are, which are laid upon this right of petitioning in England, while they promote the spirit of peace, are no check upon that of liberty; care only must be taken, lest, under the pretence of petitioning, the subject be guilty of any riot or tumult; as happened in the opening of the memorable parliament in 1640. And to prevent this, it is provided by statute, 13 Charles II. stat. 1. c. 5, that no petition to the King, or either house of parliament, for any alteration in church or state, shall be signed by above twenty persons, unless the matter thereof be approved by three justices of the peace, or the major part of the grand jury in the county; and in London, by the Lord Mayor, Aldermen, and Common Council; nor shall any petition be presented by more than ten persons at a time. But under these regulations, it is declared by the Bill of Rights, that the subject hath a right to petition; and that all commitments and prosecutions for such petitioning are illegal. The sanction of the grand jury may be given either at the assizes or quarter sessions; the punishment for offending against the stat. 13 Charles II. not to exceed a fine of 100*l.* and three months imprisonment. Upon the trial of Lord George Gordon, the Court of King's Bench declared, that they were clearly of opinion, that this statute was not in any degree affected by the Bill of Rights.

In the several articles above enumerated, consist the rights, or as they are more frequently termed, the liberties, of Englishmen. Liberties more generally talked of than thoroughly understood; and yet highly necessary to be perfectly known and considered by every man of

rank or property, lest his ignorance of the points whereon they are founded, should hurry him into faction and licentiousness on the one hand, or a pusillanimous indifference, and criminal submission, on the other. And all these rights and liberties it is our birthright to enjoy entire, unless where the laws of our country have laid them under necessary restraints. So that this review of our situation may fully justify the observation of a learned French author (of former times), who has professed that the English is the only nation in the world where political or civil liberty is the direct end of its constitution.

LIBRA, the *balance*, in astronomy, one of the twelve signs of the zodiac, the sixth in order; so called, because when the sun enters it, the days and nights are equal, as if weighed in a balance. See Astronomy.

Libra, in Roman antiquity, a pound weight; also a coin, equal in value to twenty denarii.

LIBRARY, an edifice or apartment destined for holding a considerable number of books placed regularly on shelves; or, the books themselves lodged in it.

The first who erected a library at Athens was the tyrant Pisistratus, which was transported by Xerxes into Persia, and afterwards brought back by Seleucus Nicanor to Athens. Plutarch says, that under Eumenes there was a library at Pergamus that contained 200,000 books. That of Ptolemy Philadelphus, according to A. Gellius, contained 700,000, which were all burnt by Cæsar's soldiers. Constantine and his successors erected a magnificent one at Constantinople, which in the eighth century contained 300,000 volumes, and among the rest one in which the Iliad and Odyssey were written in letters of gold, on the guts of a serpent; but this library was burnt by order of Leo Isaurus. The most celebrated libraries of ancient Rome were the Ulpian and the Palatine, and in modern Rome, that of the Vatican; the foundation of the Vatican library was laid by Pope Nicholas, in the year 1450; it was afterwards destroyed in the sacking of Rome, by the constable of Bourbon, and restored by Pope Sixtus V. and has been considerably enriched with the ruins of that of Heidelberg, plundered by Count Tilly in 1682. One of the most complete libraries in Europe, is that erected by Cosmo de Medicis; though it is now exceeded by that of the French King, which was begun by Francis I. augmented by Cardinal Richelieu, and completed by M. Colbert. The Emperor's library at Vienna, according to Lambecius, consists of 80,000 volumes, and 15,940 curious medals. The Bodleian library at Oxford exceeds that of any university in Europe, and even those of any of the sovereigns of Europe, except those of the Emperors of France and Germany, which are each of them older by a hundred years. It was first opened in 1602, and has since been increased by a great number of benefactors: indeed the Medicean library, that of Bessarion at Venice, and those just mentioned, exceed it in Greek manuscripts, but it outdoes them all in oriental manuscripts; and as to printed books, the Ambrosian at Milan, and that of Wolfenbuttle, are two of the most famous, and yet both are inferior to the Bodleian. The Cotton library consists wholly of manuscripts, particularly of such as relate to the history and antiquities of England; which, as they are now bound, make about 1000 volumes.

In Edinburgh there is a good library belonging to the university, well furnished with books, which are kept in good order, and cloistered up with wire doors, that none but the keeper can open; a method much more commodious than the multitude of chains used in other libraries. There is also a noble library of books and manuscripts belonging to the gentlemen of the law.

LIBRATION, in astronomy, an apparent irregularity of the moon's motion, whereby she seems to librate about her axis, sometimes from the east to the west, and now and then from the west to the east; so that the parts in the western limb or margin of the moon sometimes recede from the centre of the disc, and sometimes move towards it, by which means they become alternately visible and invisible to the inhabitants of the earth. See Moon.

Libration *of the earth*, is sometimes used to denote the parallelism of the earth's axis, in every part of its orbit round the sun.

LICHEN, in botany, a genus of the Cryptogamia Algæ class and order. Natural order of Algæ. Generic character: male flowers; vesicles conglomerated, extremely small, crowded or scattered on the disc, margin, or tips of the fronds: female flowers on the same, or on a distinct plant; receptacle roundish, flattish, convex, concave, subrevolute affixed to the margin, often differing from the frond in colour, within containing the seeds disposed in rows. This is a very numerous genus; many of the species

are of considerable use, particularly in the art of dyeing. L. rocella, or orchall, as an article of commerce, is of great importance, being extremely valuable for dyeing wool or silk any shade of purple or crimson. L. onphalodes will dye wool of a brown reddish colour, or a dull but durable crimson, paler and more lasting than that of orchall. L. islandicus is used by the Icelanders in their broth; they also dry it, and make it into bread, &c.

Lichen, in medicine, a *tetter* or *ringworm*, a cutaneous disease, defined by Dr. Willan, "an extensive eruption of papillæ affecting adults, connected with internal disorder, usually terminating in scurf, recurrent, not contagious." The Doctor has mentioned five varieties.

LICULA, in botany, a genus of the Appendix Palmæ. Natural order of Palms. Essential character: flowers all hermaphrodite; calyx and corolla three-parted; nectary sertiform; drupe. There is but one species, *viz.* L. spinosa, a native of Macassar and Celebes, where the inhabitants make much use of the narrow leaves for tobacco pipes, and broad ones for wrapping up fruit, &c.; the wood is of little use, not being durable.

LIE, in morals, denotes a criminal breach of veracity. Dr. Paley, in treating of this subject, observes, that there are falsehoods which are not lies; that is, which are not criminal: and there are lies which are not literally and directly false.

I. Cases of the first class are those: 1. Where no one is deceived; as, for instance, in parables, fables, novels, jests, tales to create mirth, or ludicrous embellishments of a story, in which the declared design of the speaker is not to inform, but to divert; compliments in the subscription of a letter; a prisoner's pleading not guilty; an advocate asserting the justice, or his belief of the justice of his client's cause. In such instances no confidence is destroyed, because none was reposed; no promise to speak the truth is violated, because none was given, or understood to be given. 2. Where the person you speak to has no right to know the truth, or, more properly, where little or no inconveniency results from the want of confidence in such cases; as where you tell a falsehood to a madman for his own advantage; to a robber, to conceal your property; to an assassin, to defeat or to divert him from his purpose. It is upon this principle, that, by the laws of war, it is allowed to deceive an enemy by feints, false colours, spies, false intelligence, and the like; but by no means in treaties, truces, signals of capitulation, or surrender: and the difference is, that the former suppose hostilities to continue, the latter are calculated to terminate or suspend them. Many people indulge in serious discourse a habit of fiction and exaggeration, in the accounts they give of themselves, of their acquaintance, or of the extraordinary things which they have seen or heard; and so long as the facts they relate are indifferent, and their narratives, though false, are inoffensive, it may seem a superstitious regard to truth to censure them merely for truth's sake. Yet the practice ought to be checked: for, in the first place, it is almost impossible to pronounce beforehand with certainty concerning any lie, that it is inoffensive, or to say what ill consequences may result from a lie apparently inoffensive: and, in the next place, the habit, when once formed, is easily extended to serve the designs of malice or interest; like all habits, it spreads indeed of itself. Pious frauds, as they are improperly enough called, pretended inspirations, forged books, counterfeit miracles, are impositions of a more serious nature. It is possible that they may sometimes, though seldom, have been set up and encouraged with a design to do good; but the good they aim at requires that the belief of them should be perpetual, which is hardly possible; and the detection of the fraud is sure to disparage the credit of all pretensions of the same nature. Christianity has suffered more injury from this cause than from all other causes put together.

II. As there may be falsehoods which are not lies, so there may be lies without literal or direct falsehood. An opening is always left for this species of prevarication, when the literal and grammatical signification of a sentence is different from the popular and customary meaning. It is the wilful deceit that makes the lie; and we wilfully deceive when our expressions are not true in the sense in which we believe the hearer apprehends them. Besides, it is absurd to contend for any sense of words in opposition to usage; for all senses of all words are founded upon usage, and upon nothing else. Or a man may act a lie; as by pointing his finger in a wrong direction when a traveller inquires of him his road, or when a tradesman shuts up his windows to induce his creditors to believe that he is abroad; for to all moral purposes, and therefore as to veracity, speech and action are the same; speech being only a

mode of action. See Paley's Moral Philosophy.

LIEUTENANT, an officer who supplies the place, and discharges the office of a superior in his absence. Of these, some are civil, as the lords-lieutenants of kingdoms, and the lords-lieutenants of counties; and others are military, as the lieutenant-general, lieutenant-general of the artillery, lieutenant-colonel, lieutenant of artillery of the Tower, lieutenants of horse, foot, ships of war, &c.

Lieutenant, *lord, of Ireland,* is properly a viceroy, and has all the state and grandeur of a king of England, except being served upon the knee. He has the power of making war and peace, of bestowing all the offices under the government, of dubbing knight, and of pardoning all crimes except high treason; he also calls and prorogues the parliament, but no bill can pass without the royal assent. He is assisted in his government by a privy-council; and, on his leaving the kingdom, he appoints the lords of the regency, who govern in his absence.

Lieutenants, *lords, of counties,* are officers, who, upon any invasion or rebellion, have power to raise the militia, and to give commissions to colonels and other officers, to arm and form them into regiments, troops, and companies. Under the lords-lieutenants, are deputy-lieutenants, who have the same power; these are chosen by the lords-lieutenants out of the principal gentlemen of each county, and presented to the King for his approbation.

Lieutenant *general,* is an officer next in rank to the general; in battle, he commands one of the wings; in a march, a detachment, or a flying-camp; also a quarter, at a siege, or one of the attacks, when it is his day of duty.

Lieutenant *of a ship of war,* the officer next in rank and power to the captain; of these there are several in a large ship, who take precedence according to the dates of their first commissions. The oldest lieutenant, during the absence of the captain, is charged with the command of the ship, as also the execution of whatever orders he may have received from the commander, relating to the King's service. The lieutenant who commands the watch at sea, keeps a list of all the officers and men thereto belonging, in order to muster them when he judges it expedient, and report to the captain the names of those who are absent from their duty. During the night-watch he occasionally visits the lower decks, or sends thither a careful officers to see that the proper centinels are at their duty, and that there is no disorder amongst the men; no tobacco smoked between decks, nor any fire or candles burning there, except the lights which are in lanterns, under the care of a proper watch, for particular purposes. He is expected to be always on deck in his watch, as well to give the necessary orders with regard to trimming the sails, and superintending the navigation, as to prevent any noise and confusion; but he is never to change the ship's course without the captain's directions, unless to avoid an immediate danger. In time of battle, the lieutenant is particularly to see that all the men are present at their quarters, where they have been previously stationed, according to the regulations made by the captain. He orders and exhorts them every where to perform their duty, and acquaints the captain at all other times of the misbehaviour of any persons in the ship, and of whatever else concerns the service or discipline.

LIFE, *duration of.* The uncertainty of the continuance of human life, has been a fruitful source of serious reflections not only to divines and moralists of all ages, but occasionally to every individual of the human race. Independent of the host of fatal diseases which are continually augmenting the list of their victims, the frequently occurring instances of persons apparently in full possession of all the requisites to the continuance of life, being unexpectedly consigned to the grave, would cause men to think life more uncertain than they generally appear to consider it, did not the experience of living from one day to another, confirmed by the whole of their past lives, impress them with the expectation of continuing so to do, while they do not feel any known impediment to it; and it is necessary to the well being of society that this idea should in general preponderate. But as the property or income from which many persons derive their subsistence depends on the continuance of their life, or that of others, cases will frequently occur in the adjustment of pecuniary concerns, in which it is desirable to be able to form an estimate of the duration of life, and as it is evidently a subject on which certainty cannot be attained, we must be content with that species of knowledge which rests on probability. This degree of knowledge, which is the limit of our acquaintance, with many

other important facts, is, in a comprehensive view of this subject, infinitely more useful and proper than more positive knowledge would be.

At whatever period the world was first inhabited, there is undoubted evidence that for at least 3000 years past the general duration of human life has been much the same as it now is; nor has any great difference been observed between the inhabitants of different climates, the negro of Africa (in some instances at least) attaining to as great age as the European. The human frame appears to adapt itself with little difficulty to the atmosphere and local peculiarities of the country in which it is born, or even into which it is afterwards removed. Thus not only the children of persons who have removed from Great Britain to different parts of the continent of North America, but also the emigrants themselves, have been found to live as long as in the former country. Men can live equally well under very different circumstances; it is sudden changes that are injurious to the human frame; and temperate climates being less liable to such changes are found to be most favourable to the duration of life. There are however, in almost every country, particular districts in which the inhabitants are found to live longer than in other situations, which proceeds chiefly from a free circulation of air, uncontaminated by the noxious vapours and exhalations which destroy its purity in other parts; thus hilly districts are almost universally found to furnish more instances of long life, than low and marshy situations.

The knowledge of the duration of human life in general, and of its probable continuance at all ages, has been ascertained with sufficient correctness for all practical purposes, from the observations which have been made on the bills of mortality of different places. Dr. Halley formed a table of the probabilities of life from the registers of the births and burials of the inhabitants of the city of Breslaw, the capital of the duchy of Silesia in Germany, from the year 1687 to 1691. A similar table was formed by Mr. Thomas Simpson from the London bills of mortality, from 1728 to 1737; and other tables of the same kind have been since published by M. Dupré de St. Maur, M. Kerseboom, M. de Parcieux, Dr. Price, and others, from which the following are selected.

TABLE I. Shewing the Probabilities of the Duration of Human Life at all Ages, formed from the Register of Mortality at Northampton, for 46 Years from 1735 to 1780.

Age.	Persons living.	Decrem. of Life.	Age.	Persons living.	Decrem. of Life.	Age.	Persons living.	Decrem. of Life.	Age.	Persons living.	Decrem. of Life.
0	11650	3000	25	4760	75	49	2936	79	73	992	80
1	8650	1367	26	4685	75	50	2857	81	74	912	80
2	7283	502	27	4610	75	51	2776	82	75	832	80
3	6781	335	28	4535	75	52	2694	82	76	752	77
4	6446	197	29	4460	75	53	2612	82	77	675	73
5	6249	184	30	4385	75	54	2530	82	78	602	68
6	6065	140	31	4310	75	55	2448	82	79	534	65
7	5925	110	32	4235	75	56	2366	82	80	469	63
8	5815	80	33	4160	75	57	2284	82	81	406	60
9	5735	60	34	4085	75	58	2202	82	82	346	57
10	5675	52	35	4010	75	59	2120	82	83	289	55
11	5623	50	36	3935	75	60	2038	82	84	234	48
12	5573	50	37	3860	75	61	1956	82	85	186	41
13	5523	50	38	3785	75	62	1874	81	86	145	34
14	5473	50	39	3710	75	63	1793	81	87	111	28
15	5423	50	40	3635	76	64	1712	80	88	83	21
16	5373	53	41	3559	77	65	1632	80	89	62	16
17	5320	58	42	3482	78	66	1552	80	90	46	12
18	5262	63	43	3404	78	67	1472	80	91	34	10
19	5199	67	44	3326	78	68	1392	80	92	24	8
20	5132	72	45	3248	78	69	1312	80	93	16	7
21	5060	75	46	3170	78	70	1232	80	94	9	5
22	4985	75	47	3092	78	71	1152	80	95	4	3
23	4910	75	48	3014	78	72	1072	80	96	1	1
24	4835	75									

The probability that a life of any present age shall continue a certain number of years, or shall attain to any other given age, is the fraction whose numerator is the number of the living in the table opposite to the given age, and the denominator the number opposite to the present age of the given life. Thus the probability that a life of 25 shall attain to the age of 45, or live 20 years, is $\frac{3248}{4760}$. The difference between this fraction and unity gives the probability that the event will not happen; the probability that a life of 25 will not live 20 years, is therefore $\frac{1512}{4760}$, consequently the odds of living to dying in this period are more than 2 to 1. The probability that a person of 32 years of age shall attain to 59 years, appears by the table to be $\frac{2120}{4235}$, or nearly an even chance.

In order to find the expectation of life at any age, from a table, like the above, which shows the number that die annually at all ages, divide the sum of all the living in the table, at the age whose expectation is required and at all greater ages, by the sum of all that die annually at that age and above it; or, which is the same, by the number of the living at that age; and half unity subtracted from the quotient will give the expectation required. Thus, at the age of 65, the sum of all the living at that and all greater ages, is 18,580; the number living at that age is 1,632; and the former number divided by the latter, and half unity subtracted from the quotient, gives 10.88 for the expectation of the age of 65. In this manner the following table is formed.

TABLE II.

Shewing the Expectations of Human Life at every Age, deduced from the Northampton Table of Observations.

Ages.	Expect.	Ages.	Expect.	Ages.	Expect.	Ages.	Expect.	Ages.	Expect.	Ages.	Expect.
0	25.18	17	35.20	33	26.72	49	18.49	65	10.88	81	4.41
1	32.74	18	34.58	34	26.20	50	17.99	66	10.42	82	4.09
2	37.79	19	33.99	35	25.68	51	17.50	67	9.96	83	3.80
3	39.55	20	33.43	36	25.16	52	17.02	68	9.50	84	3.58
4	40.58	21	32.90	37	24.64	53	16.54	69	9.05	85	3.37
5	40.84	22	32.39	38	24.12	54	16.06	70	8.60	86	3.19
6	41.07	23	31.88	39	23.60	55	15.58	71	8.17	87	3.01
7	41.03	24	31.36	40	23.08	56	15.10	72	7.74	88	2.86
8	40.79	25	30.85	41	22.56	57	14.63	73	7.33	89	2.66
9	40.36	26	30.33	42	22.04	58	14.15	74	6.92	90	2.41
10	39.78	27	29.82	43	21.54	59	13.68	75	6.54	91	2.09
11	39.14	28	29.30	44	21.03	60	13.21	76	6.18	92	1.75
12	38.49	29	28.79	45	20.52	61	12.75	77	5.83	93	1.37
13	37.83	30	28.27	46	20.02	62	12.28	78	5.48	94	1.05
14	37.17	31	27.76	47	19.51	63	11.81	79	5.11	95	0.75
15	36.51	32	27.24	48	19.00	64	11.35	80	4.75	96	0.50
16	35.85										

These tables suggest an easy method of finding the number of inhabitants of a place from the bills of mortality; for, supposing the yearly births and deaths equal, it is only necessary to find, in the way above described, the expectation of an infant just born, and this multiplied by the number of yearly births will be the number of inhabitants.

From all the observations which have been made on the bills of mortality of different places, the fact is fully ascertained, that the duration of human life is greater in all its stages in country parishes and moderate sized towns, than in large and crowded cities. According to Simpson's correction of Smart's Table for London, only one in 44 of the inhabitants attain to the age of 80 years; Dr. Price gives the proportion somewhat greater, or about 1 in 40, but observes that of those who are natives of London, a much less

proportion arrive to that age. The proportion of the inhabitants of other places that live to the age of 80, has been found as follows:

At Edinburgh	1	in 42
Vienna	1	in 41
Breslaw	1	in 41
Berlin	1	in 37
Norwich	1	in 27
Northampton	1	in 24
Pais de Vaud	1	in 21½

Among any considerable number of lives selected from the common mass, such as the nominees to a tontine, or the members of an assurance or annuity society, the duration of life will always be found greater than it is represented by tables formed from general bills of mortality. Thus, M. Kersseboom found that among the state annuitants in Holland, 1 in 14 lived to upwards of 80 years of age, and the nominees to the life annuities granted by the governments of France and Great Britain, have been found to live longer than the duration given by any table formed from bills of mortality. In some few country situations, where the injurious habits and artificial mode of living which prevail in large cities have made little progress, the duration of life has been found unusually great; thus, at Ackworth, in Yorkshire, 1 in 14 died turned of 80 years of age; and, according to an account of the parish of Kingham in New England, in the first volume of "Memoirs of the American Academy," the number of deaths in 54 years had been 1113, of which 1 in 13 had survived 80 years.

Life *annuities*. See Annuities. Life annuities secured by land, differ from those already described only in this, that the annuity is to be paid up to the very day of the death of the age in question, or of the person upon whose life the annuity is granted. To obtain the more exact value, therefore, of such an annuity, a small sum must be added to the same, as computed by the rules in the article Annuities, which will be different according as the payments are yearly, half-yearly, or quarterly. Dr. Price has entered at large on the subject; and, according to him, the addition is,

$\frac{y}{2n}$ for annual payments.

$\frac{h}{4n}$ for half-yearly payments.

$\frac{q}{8n}$ for quarterly payments.

Here n is the complement of the given age, or what it wants of 86 years; and y, h, q, are the respective values of an annuity certain of n years, payable yearly, half-yearly, or quarterly. It is found, as the result of many investigations, that the first of these additional quantities is about

$\frac{1}{5}$th of one year's purchase.

The second $\frac{1}{10}$th.

The third $\frac{1}{20}$th.

Life *boat*. See Boat.

Life *estates*, or *estates for life*, are of two kinds; either such as are created by the act of the parties, or such as are created by the operation of law, as estates by the curtesy or dower. Estates for life, created by deed or grant, are, where a lease is made of lands or tenements to a man, to hold for the term of his own life, or for that of another person, or for more lives than one; in any of which cases he is called tenant for life, only, when he holds the estate by the life of another, he is usually termed tenant *pur auter vie*, for another's life. Estates for life may be created not only by the express terms before mentioned, but also by a general grant, without defining or limiting any specific estate. Where estates are granted for the lives of others, and they absent themselves seven years, and no proof is made of their being in existence; in any action commenced for the recovery of such tenements by the lessors or reversioners, they shall be accounted as dead, and the jury shall give their verdict accordingly; (19 Charles II. c. 6.) and, on application to the Chancellor, the party holding such estates may be compelled to produce the persons on whose lives such estates depend.

LIGAMENT, in anatomy, a strong compact substance, serving to join two bones together.

A ligament is more flexible than a cartilage, not easily ruptured or torn, and does not yield, or at least very little, when pulled.

LIGHT, is that principle or thing by which objects are made perceptible to our sense of seeing; or the sensation occasioned in the mind by the view of luminous objects. The nature of light has been a subject of speculation from the first dawnings of philosophy. Some of the earliest philosophers doubted whether objects became visible by means of any thing proceeding from them, or from the eye of the spectator; but this opinion was qualified by Empedocles and Plato, who maintained, that vision was occasion-

ed by particles continually flying off from the surfaces of bodies, which met with others proceeding from the eye; while the effect was ascribed by Pythagoras solely to the particles proceeding from the external objects, and entering the pupil of the eye. But Aristotle defines light to be the act of a transparent body, considered as such; and he observes, that light is not fire, nor yet any matter radiating from the luminous body, and transmitted through the transparent one.

The Cartesians have refined considerably on this notion; and hold that light, as it exists in the luminous body, is only a power or faculty of exciting in us a very clear and vivid sensation; or that it is an invisible fluid present at all times and in all places, but requiring to be set in motion by a body ignited, or otherwise properly qualified to make objects visible to us.

Father Malbranche explains the nature of light from a supposed analogy between it and sound. Thus, he supposes all the parts of a luminous body are in a rapid motion, which, by very quick pulses, is constantly compressing the subtle matter between the luminous body and the eye, and excites vibrations of pression: as these vibrations are greater, the body appears more luminous; and as they are quicker or slower, the body is of this or that colour. The Newtonians maintain, that light is not a fluid, but consists of a great number of very small particles, thrown off from the luminous body by a repulsive power, with an immense velocity, and in all directions. And these particles, it is also held, are emitted in right lines: which rectilinear motion they preserve till they are turned out of their path by some of the following causes, *viz.* by the attraction of some other body near which they pass, which is called inflection, or by passing obliquely through a medium of different density, which is called refraction; or by being turned aside by the opposition of some intervening body, which is called reflection; or, lastly, by being totally stopped by some substance into which they penetrate, and which is called their extinction. A succession of these particles following one another, in an exact straight line, is called a ray of light; and this ray, in whatever manner its direction may be changed, whether by refraction, reflection, or inflection, always preserves a rectilinear course, till it be again changed; neither is it possible to make it move in the arch of a circle, ellipsis, or other curve. For the above properties of the rays of light, see the several words Refraction, Reflection, &c.

The velocity of the rays of light is truly astonishing, amounting to nearly two hundred thousand miles in a second of time, which is about a million times greater than the velocity of a cannon ball. And this amazing motion of light has been manifested in various ways, and first from the eclipses of Jupiter's satellites. It was first observed by Roemer, that the eclipses of those satellites happen sometimes sooner, and sometimes later, than the times given by the tables of them; and that the observation was before or after the computed time, according as the earth was nearer to, or further from Jupiter, than the mean distance. Hence Roemer and Cassini both concluded, that this circumstance depended on the distance of Jupiter from the earth; and that, to account for it, they must suppose that the light was about fourteen minutes in crossing the earth's orbit. This conclusion, however, was afterwards abandoned, and attacked by Cassini himself: but Roemer's opinion found an able advocate in Dr. Halley, who removed Cassini's difficulty, and left Roemer's conclusion in its full force.

It has since been found, by repeated experiments, that when the earth is exactly between Jupiter and the sun, his satellites are seen eclipsed eight minutes and a quarter sooner than they could be according to the tables; but when the earth is nearly in the opposite point of its orbit, these eclipses happen about eight minutes and a quarter later than the tables predict them. Hence, then, it is certain that the motion of light is not instantaneous, but that it takes up about sixteen minutes and a half of time to pass over a space equal to the diameter of the earth's orbit, which is at least one hundred and ninety millions of miles in length, or at the rate of near two hundred thousand miles per second, as above-mentioned.

Hence, therefore, light takes up about eight minutes and a quarter in passing from the sun to the earth; so that, if he should be annihilated, we should see him for eight minutes and a quarter after that event should happen; and if he were again created, we should not see him till eight minutes and a quarter afterwards. Hence also, it is easy to know the time in which light travels to the earth, from the moon, or any of the other planets, or even from the fixed stars, when their distances shall be known; these distances are, however, so immensely great, that

from the nearest of them, supposed to be Sirius, the dog-star, light takes up many years to travel to the earth: and it is even suspected, that there are many stars whose light has not yet arrived at us since their creation. And this, by-the-bye, may perhaps sometimes account for the appearance of new stars in the heavens. Our excellent astronomer, Dr. Bradley, afterwards found nearly the same velocity of light as Roemer, from his accurate observations, and most ingenious theory, to account for some apparent motions in the fixed stars; for an account of which, see Aberration *of light.* By a long series of these observations, he found the difference between the true and apparent place of several fixed stars, for different times of the year; which difference could no otherwise be accounted for, than for the progressive rays of light. From the mean quantity of this difference, he ingeniously found, that the ratio of the velocity of light to the velocity of the earth in its orbit, was as 10,313 to 1, or that light moves 10,313 times faster than the earth moves in its orbit about the sun; and as this latter motion is at the rate of $18\frac{11}{12}$ miles per second nearly, it follows that the former, or the velocity of light, is at the rate of about 195,000 miles in a second; a motion, according to which it will require just 8′ 7″ to move from the sun to the earth, or about 95,000,000 of miles.

It was also inferred, from the foregoing principles, that light proceeds with the same velocity from all the stars. And hence it follows, if we suppose that all the stars are not equally distant from us, as many arguments prove, that the motion of light, all the way it passes through the immense space above our atmosphere, is equable or uniform. And since the different methods of determining the velocity of light thus agree in the result, it is reasonable to conclude, that in the same medium, light is propagated with the same velocity after it has been reflected as before. For an account of Mr. Melville's hypothesis of the different velocities of differently coloured rays, see Colour.

To the doctrine concerning the materiality of light, and its amazing velocity, several objections have been made, of which the most considerable is; that as rays of light are continually passing in different directions from every visible point, they must necessarily interfere with each other in such a manner as entirely to confound all distinct perception of objects, if not quite to destroy the whole sense of seeing; not to mention the continual waste of substance, which a constant emission of particles must occasion in the luminous body, and thereby, since the creation must have greatly diminished the matter in the sun and stars, as well as increased the bulk of the earth and planets, by the vast quantity of particles of light absorbed by them in so long a period of time. But it has been replied, that if light were not a body, but consisted in mere pression or pulsion, it could never be propagated in right lines, but would be continually inflected *ad umbram.* Thus, Sir Isaac Newton: "A pressure on a fluid medium, *i. e.* a motion propagated by such a medium, beyond any obstacle, which impedes any part of its motion, cannot be propagated in right lines, but will be always inflecting and diffusing itself every way, to the quiescent medium beyond that obstacle.

The power of gravity tends downwards; but the pressure of water arising from it tends every way with an equable force, and is propagated, with equal ease and equal strength, in curves as in straight lines. Waves, on the surface of the water, gliding by the extremes of any very large obstacle, inflate and dilate themselves, still diffusing gradually into the quiescent water beyond that obstacle. The waves, pulses, or vibrations of the air, wherein sound consists, are manifestly inflected, though not so considerably as the waves of water; and sounds are propagated with equal ease through crooked tubes and through straight lines; but light was never known to move in any curve, nor to inflect itself *ad umbram.*"

It must be acknowledged, however, that many philosophers, both English and foreigners, have recurred to the opinion, that light consists of vibrations propagated from the luminous body, through a subtle ethereal medium.

Dr. Franklin, in a letter dated April 23, 1752, expresses his dissatisfaction with the doctrine, that light consists of particles of matter continually driven off from the sun's surface, with so enormous a swiftness. "Must not," says he, "the smallest portion conceivable have, with such a motion, a force exceeding that of a twenty-four pounder discharged from a cannon? Must not the sun diminish exceedingly by such a waste of matter; and the planets, instead of drawing nearer to him, as some have feared, recede to great-

er distances, through the lessened attraction? yet these particles, with this amazing motion, will not drive before them, or remove, the least and slightest dust they meet with, and the sun appears to continue of his ancient dimensions, and his attendants move in their ancient orbits." He therefore conjectures, that all the phenomena of light may be more properly solved, by supposing all space filled with a subtle elastic fluid, which is not visible when at rest, but which, by its vibrations, affects the fine sense in the eye, as those of the air affect the grosser organs of the ear; and even that different degrees of the vibration of this medium may cause the appearances of different colours. Franklin's Exper. and Observ. 1769, p. 264.

The celebrated Euler has also maintained the same hypothesis, in his "Theoria Lucis et Colorum." In the summary of his arguments against the common opinion, recited in Acad. Berl. 1752, p. 271, besides the objections above-mentioned, he doubts the possibility, that particles of matter, moving with the amazing velocity of light, should penetrate transparent substances with so much ease. In whatever manner they are transmitted, those bodies must have pores, disposed in right lines, and in all possible directions, to serve as canals for the passage of the rays; but such a structure must take away all solid matter from those bodies, and all coherence among their parts, if they do contain any solid matter.

Among modern philosophers who have supported this doctrine, Dr. Young has shown much ability in his experimental and theoretical researches, in his memoirs in the "Philosophical Transactions," which have been republished in his "Lectures," and in "Nicholson's Journal."

The expansion or extension of any portion of light is inconceivable. Dr. Hook shows, that it is as unlimited as the universe, which he proves from the immense distance of many of the fixed stars, which only become visible to the eye by the best telescopes. "Nor," adds he, "are they only the great bodies of the sun or stars that are thus liable to disperse their light through the vast expanse of the universe, but the smallest spark of a lucid body must do the same, even the smallest globule struck from a steel by a flint."

The intensity of different lights, or of the same light in different circumstances, affords a curious subject of speculation. M. Bouguer, Traité de Optique, found, that when one light is from sixty to eighty times less than another, its presence or absence will not be perceived by an ordinary eye; that the moon's light, when she is 19° 16′ high above the horizon, is about one-third of her light, at 66° 11′ high; and when one limb just touched the horizon, her light was but the 2,000th part of her light at 66° 11′ high; and that hence light is diminished in the proportion of three to one, by traversing 7.469 toises of dense air. He found also, that the centre of the sun's disc is considerably more luminous than the edges of it; whereas both the primary and secondary planets are more luminous at their edges than near their centres: that, further, the light of the sun is about 300,000 times greater than that of the moon; and therefore it is no wonder that philosophers have had so little success in their attempts to collect the light of the moon with burning glasses; for, should one of the largest of them even increase the light 1,000 times, it will still leave the light of the moon in the focus of the glass, 300 times less than the intensity of the common light of the sun.

Dr. Smith, in his optics, vol. i. p. 29, thought he had proved that the light of the full moon would be only the 90,900th part of the full day-light, if no rays were lost at the moon. But Mr. Robins, in his Tracts, vol. ii. p. 225, shows that this is too great by one half. And Mr. Mitchell, by a more easy and accurate mode of computation, found that the density of the sun's light on the surface of the moon, is but the 45,000th part of the density at the sun; and that, therefore, as the moon is nearly of the same apparent magnitude as the sun, if she reflected to us all the light received on her surface, it would be only the 45,000th part of our day-light, or that which we receive from the sun. Admitting, therefore, with M. Bouguer, that the moon's light is only the 300,000th part of the day, or sun's light, Mr. Mitchell concludes that the moon reflects no more than between the 6th and 7th part of what she receives.

Sir I. Newton long ago observed, that bodies and light act mutually on one another; bodies on light, in emitting, reflecting, refracting, and inflecting it; and light on bodies, by heating them, and putting their parts into a vibrating motion, in which heat principally consists. For all fixed bodies, he observes, when heat-

ed beyond a certain degree, do emit light, and shine.

This action of bodies on light is found to exert itself at a sensible distance, though it always increases as the distance is diminished, as appears very sensibly in the passage of a ray between the edges of two very thin planes, at different apertures; which is attended with this peculiar circumstance, that the attraction of one edge is increased as the other is brought nearer it.

The rays of light, in their passage out of glass into a vacuum, are not only inflected towards the glass, but if they fall too obliquely, they will revert back again to the glass, and be totally reflected. Now the cause of this reflection cannot be attributed to any resistance of the vacuum, but must be entirely owing to some force or power in the glass, which attracts or draws back the rays as they were passing into the vacuum. And this appears further from hence, that if you wet the back surface of the glass with water, oil, honey, or a solution of quicksilver, then the rays, which would otherwise have been reflected, will pervade and pass through that liquor; which shows that the rays are not reflected till they come to that back surface of the glass, nor even till they begin to go out of it; for if at their going out they fall into any of the aforesaid mediums, they will not then be reflected, but will persist in their former course, the attraction of the glass being in this case counterbalanced by that of the liquor.

M. Maraldi prosecuted experiments similar to those of Sir I. Newton, on inflected light. And his observations chiefly respect the inflection of light towards other bodies, by which their shadows are partially illuminated. Acad. Paris, 1723, Mem. p. 159. See also Priestley's Hist. p. 521, &c.

From the mutual attraction between the particles of light and other bodies, arise two other grand phenomena, besides the inflection of light, which are called the reflection and refraction of light. It is well known that the determination of bodies in motion, especially elastic ones, is changed by the interposition of other bodies in their way; thus also light, impinging on the surfaces of bodies, should be turned out of its course, and beaten back or reflected, so as, like other striking bodies, to make the angle of its reflection equal to the angle of incidence. This, it is found by experience, light does; and yet the cause of the effect is different from that just now assigned, for the rays of light are not reflected by striking on the very parts of the reflecting bodies, but by some power equally diffused over the whole surface of the body, by which it acts on the light, either attracting or repelling it, without contact: by which same power, in other circumstances, the rays are refracted; and by which also the rays are first emitted from the luminous body; as Newton abundantly proves by a great variety of arguments. See Reflection and Refraction.

That great author put it past doubt, that all those rays which are reflected do not really touch the body, though they approach it infinitely near; and that those which strike on the parts of solid bodies adhere to them, and are, as it were, extinguished and lost. Since the reflection of the rays is ascribed to the action of the whole surface of the body without contact, if it be asked how it happens that all the rays are not reflected from every surface, but that, while some are reflected, others pass through and are refracted? the answer given by Newton is as follows: Every ray of light, in its passage through any refracting surface, is put into a certain transient constitution or state, which in the progress of the ray returns at equal intervals, and disposes the ray at every return to be easily transmitted through the next refracting surface, and between the returns to be easily reflected by it: which alteration of reflection and transmission, it appears, is propagated from every surface, and to all distances. What kind of action or disposition this is, and whether it consist in a circulating or vibrating motion of the ray, or the medium, or something else, he does not inquire; but allows those who are fond of hypothesis to suppose that the rays of light, by impinging on any reflecting or refracting surface, excite vibrations in the reflecting or refracting medium, and by that means agitate the solid parts of the body. These vibrations, thus produced in the medium, move faster than the rays, so as to overtake them; and when any ray is in that part of the vibration which conspires with its motion, its velocity is increased, and so it easily breaks through a refracting surface; but when it is in a contrary part of the vibration, which impedes its motion, it is easily reflected; and thus every ray is successively disposed to be easily reflected or transmitted by every vibration which meets it. These returns in the disposition of any ray to be reflected, he calls

fits of easy reflection; and the returns in the disposition to be transmitted, he calls fits of easy transmission; also the space between the returns, the interval of the fits. Hence then the reason why the surfaces of all thick transparent bodies reflect part of the light incident upon them, and refract the rest, is, that some rays, at their incidence, are in fits of easy reflection, and others of easy transmission. For the properties of reflected light, see MIRROR, OPTICS, &c.

Again, a ray of light passing out of one medium into another of different density, and in its passage making an oblique angle with the surface that separates the mediums, will be refracted, or turned out of its direction; because the rays are more strongly attracted by a denser, than by a rarer medium. That these rays are not refracted by striking on the solid parts of bodies, but that this is effected without a real contact, and by the same force by which they are emitted and reflected, only exerting itself differently in different circumstances, is proved, in a great measure, by the same arguments by which it is demonstrated that reflection is performed without contact.

When light is refracted by a prism, or other transparent body, it is divided into rays, exciting the sensation of different colours; namely, red, orange, yellow, green, blue, indigo, and violet. This is the enumeration followed by Newton and others, which supposes seven rays refrangible in the above order, the red being least refrangible, and the violet most so, and that the other tints are produced by mixture. The image formed by the different rays, thus separated, forms the solar spectrum. Dr. Wollaston has shown, by looking through the prism at a narrow line of light, that the primitive colours are only red, green, blue, and violet.

Heat and light are not present in corresponding degrees, in different parts of the solar spectrum; for, generally speaking, those rays illuminate most that have the least heating power. The rays in the centre of the spectrum have the greatest illuminating power, as may be ascertained by viewing, successively in each, a small body, such as the head of a common nail. It will be seen most distinctly in the light green, or deep yellow rays, and less plainly towards either extremity of the spectrum.

The heating power of the rays follows a different order. If the bulb of a sensible thermometer be moved, in succession, through the differently coloured rays, it will be found to indicate the greatest heat in the red rays, next in the green, and so on, in a diminishing progression, to the violet. When the thermometer is removed entirely out of the confines of the red rays, but with its ball still in the line of the spectrum, it rises even higher than in the red rays; and continues to rise, till removed half an inch beyond the extremity of the red ray. The ball of the thermometer employed for this purpose should be extremely small, and should be blackened with Indian ink. An air thermometer is better adapted than a mercurial one, to exhibit the minute change of temperature that ensues. These invisible heat-making rays may be reflected by the mirror, and refracted by the lens, exactly in the same manner as the rays of light.

Beyond the confines of the spectrum on the other side, *viz.* a little beyond the violet ray, the thermometer is not affected; but in this place it is remarkable, that there are also invisible rays of a different kind, which exert all the chemical effects of the rays of light, and even with greater energy. One of the chemical properties of light is, that it speedily changes from white to black the fresh precipitated muriate of silver. This effect is produced most rapidly by the direct light of the sun; and the rays, as separated by the prism, have this property in various degrees. The blue rays, for example, effect a change of the muriate of silver in fifteen seconds, which the red require twenty minutes to accomplish; and, generally speaking, the power diminishes as we recede from the violet extremity. But entirely out of the spectrum, and beyond the violet rays, the effect is still produced. Hence it appears that the solar beams consist of three distinct kinds of rays; of those that excite heat, and promote oxydation; of illuminating rays; and of de-oxydizing rays. A striking illustration of the different power of these various rays, is furnished by their effect on phosphorus. In the rays beyond the red extremity, phosphorus is heated, smokes, and emits white fumes; but these are presently suppressed on exposing it to the de-oxydizing rays which lie beyond the violet extremity.

There is an exception, however, as stated by Dr. Wollaston, to the de-oxydizing power of the rays above-mentioned. The substance, termed gum-guiacum, has the property, when exposed to the light, of changing from a yellowish colour to green; and this effect he has ascertained

to be connected with the absorption of oxygen. Now, in the most refrangible rays, which would fall beyond the violet extremity, he found that this substance became green, and was again changed to yellow by the least refrangible. This is precisely the reverse of what happens to muriate of silver, which is blackened, or de-oxydized, by the most refrangible; and has its colour restored, or is again oxygenized, in the least refrangible rays.

Certain bodies have the property of absorbing the rays of light in their totality, of retaining them for some time, and of again evolving them unchanged, and unaccompanied by sensible heat. Thus, in an experiment of Du Fay, a diamond exposed to the sun, and immediately covered with black wax, shone in the dark, on removing the wax, at the expiration of several months. Bodies possessing this property, are called *solar phosphori*: such are the Canton's, Baldwin's, Homberge's, and the Bolognian phosphori. To the same class belong several natural bodies which retain light, and give it out unchanged. Thus, snow is a natural solar phosphorus. So also is, occasionally, the sea when agitated; putrid fish have a similar property; and the glow-worm belongs to the same class. These phenomena are independant of every thing like combustion; for artificial phosphori, after exposure to the sun's rays, shine in the dark when placed in the vacuum of an air-pump, or under water, &c. where no air is present to effect combustion.

From solar phosphori, the extrication of light is facilitated by the application of an elevated temperature; and, after having ceased to shine at the ordinary temperature, they again emit light when exposed to an increase of heat. Several bodies, which do not otherwise give out light, evolve it, or become phosphorescent when heated. Thus powdered fluate of lime becomes luminous when thrown on an iron plate, raised to a temperature rather above that of boiling water. The yolk of an egg, when dried, becomes luminous on being heated; and so also does tallow during liquefaction. To exhibit the last mentioned fact, it is merely necessary to place a lump of tallow on a coal, heated below ignition, making the experiment in a dark room. Attrition also evolves light, in many instances, by the part rubbed becoming ignited. Thus, rock crystal, and other hard stones, shine when rubbed against each other; and two pieces of common bonnet cane, rubbed strongly against each other in the dark, emit a faint light; most probably from the silex they contain: and two pieces of borax have the same property much more remarkably.

Light is disengaged in various cases of chemical combination. Whenever combustion is a part of the phenomena, this is well known to happen; but light is evolved also, in other instances, where nothing like combustion goes forwards. Thus, fresh-prepared pure magnesia, added suddenly to highly concentrated sulphuric acid, exhibits a red heat.

Whence comes the light afforded by ignited bodies? whether it have been previously imbibed by them? whether the commencement of ignition be distinctive of the same temperature in all bodies? whether the great planetary sources of light be bodies in a state of combustion, or merely luminous upon principles very different from any which our experiments can point out? whether the momentum of the particles of light, or their disposition for chemical combination, be the most effectual in the changes produced by its agency?—these, and numerous other interesting questions, must be left for future research and investigation. See Combustion.

The production of light by inflammation is an object of great importance to society at large, as well as to the chemist. It appears to arise immediately from the strong ignition of a body while rapidly decomposing. Most solid bodies in combustion are kept, partly from a want of the access of air, and partly from the vicinity of conducting bodies, at a low degree of ignition. But when vapours rapidly escape into the air, it may, and does frequently happen, that the combustion, instead of being carried on merely at the surface of the mass, penetrates to a considerable depth within, and from this, as well as from the imperfect conducting power of the surrounding air, a white heat, or very strong ignition, is produced. The effect of lamps and candles depends upon these considerations. A combustible fluid, most commonly of the nature of fat oil, is put in a situation to be absorbed between the filaments of cotton, linen, fine wire, or asbestos. The extremity of this fibrous substance, called the wick, is then considerably heated. The oil evaporates, and its vapour takes fire. In this situation the wick, being enveloped with flame, is kept at such a temperature, that the oil continually boils, is evaporated, burns, and by these means keeps up a constant flame. Much of the perfection of this experiment depends on the nature, quantities, and figure of the materials

made use of. If the wick be too large, it will supply a greater quantity of the fluid than can be well decomposed. Its evaporation will therefore diminish the temperature, and consequently the light, and afford a fuliginous column, which will pass through the centre of the flame, and fly off in the form of smoke. The magnitude of the wick may, from time to time, in candles, be reduced, as to length, by snuffing; but this operation will not remedy the evils which arise from too great a diameter. If the oil be not sufficiently combustible, the ignition will be but moderate, and the flame yellow; and the same effect will be produced, if the air be not sufficiently pure and abundant. An experiment to this effect may be made by including the flame of a small candle or lamp in a glass tube of about one inch in diameter, standing on the surface of a table. The air which passes between the glass and the table, will be sufficient to maintain a very bright flame; but if a metallic covering, perforated with a hole of about a quarter of an inch in diameter, be laid upon the upper orifice of the tube, the combustion will be so far impeded, that the flame will be perceptibly yellower. The hole may then be more or less closed at pleasure by sliding a small piece of metal, for example a shilling, over it. The consequence will be, that the flame will become more and more yellow, will at length emit smoke, and if the whole be entirely closed, extinction will follow.

The smell arising from the volatile parts which pass off not well consumed from a lamp or candle, must be different according to the nature of those parts. This depends chiefly on the oil, but in some measure upon the wick. When a candle with a cotton wick is blown out, the smell is considerably more offensive, than if the wick be of linen, or of rush; but less offensive than if the supply of the combustion had been oil. Whenever a candle or lamp is removed, the combustion is in some measure impeded by the stream of cold air, against which it strikes. Smoke is accordingly emitted from its anterior side, and the peculiar smell is perceived. From this imperfection, lamps are much less adapted to be carried from place to place than candles.

From the necessity of the access of air, there will be more light produced from a lamp with a number of small wicks, than with one large one, or from a number of small candles, than the same quantity of tallow used to make a single large one. In the lamp of Argand, the wick consists of a web of cloth in the form of a pipe or tube, the longitudinal fibres of which are thicker than the circular ones. This is passed by a suitable contrivance into a cylindrical cavity, which contains the oil; and there are other precautions in the construction of the apparatus, by which the oil is regularly supplied, the access of air is duly permitted, as well within as without the circle formed by the upper edge of this cylindrical wick, and this edge can be raised or lowered at pleasure. Hence the possessor has it in his power to regulate the surface of the wick, so that the greatest flame consistent with perfect combustion may be produced; and the steadiness of the flame is secured by a glass shade or tube, which surrounds it, and in a certain degree accelerates the current of air.

In the illumination by candles, where the fused matter is contained in a cup or cavity of the matter not yet fused, it is of some consequence, whether the substance be fusible at a high or low temperature. The difference between wax and tallow candles arises from this property. Wax being less fusible, will admit of a thinner wick, and needs no snuffing; but in a tallow candle it is absolutely necessary to have a large wick, capable of taking up the tallow as it melts.

The difference of effect in illumination between a thick and a thin wick cannot be better shown, than by remarking the appearances produced by both. When a candle with a thick wick is first lighted, and the wick snuffed short, the flame is perfect and luminous, unless its diameter be very great; in which last case, there is an opaque part in the middle, where the combustion is impeded for want of air. As the wick becomes longer, the space between its upper extremity and the apex of the flame is diminished; and, consequently, the oil, which issues from that extremity, having a less space of ignition to pass through, is less completely burned, and passes off partly in smoke. This evil continues to increase, until at length the upper extremity of the wick projects beyond the flame, and forms a support for an accumulation of soot, which is afforded by the imperfect combustion. A candle in this situation affords scarcely one-tenth of the light, which the due combustion of its materials would produce; and tallow candles, on this account, require continual snuffing. But, on the contrary, if we consider the wax candle,

we find, that as its wick lengthens, the light indeed becomes less, and the cup becomes filled with melted wax. The wick, however, being thin and flexible, does not long occupy its place in the centre of the flame; neither does it, when there, enlarge the diameter of the flame, so as to prevent the access of air to its internal part. When its length is too great for the vertical position, it bends on one side; and its extremity, coming into contact with the air, is burned to ashes, excepting such a portion as is defended by the continual afflux of melted wax, which is volatilized and completely burned by the surrounding flame. We see, therefore, that the difficult fusibility of wax renders it practicable to burn a large quantity of fluid by means of a small wick; and that this small wick, by turning on one side in consequence of its flexibility, performs the operation of snuffing upon itself, in a much more accurate manner than it can ever be performed mechanically.

Mr. Henry made some experiments on the light afforded by the combustion of different gases, and found, that it was apparently in the ratio of the oxygen that entered into combination with the hydrogen they contained. Thus, 100 parts of pure hydrogen gas required from 50 to 54 of oxygen; 100 of gas from oak, 42; from moist charcoal and from dried peat, each 50; from lamp oil 136; from coal 140; from wax 166; pure olifiant gas 210. Tallow is nearly on a par with oil. The production of light from the first four was so trifling, that they did not seem applicable to œconomical purposes.

Light *from plants.* In Sweden a very curious phenomena has been observed on certain flowers by M. Haggern, lecturer in natural history. One evening he perceived a faint flash of light repeatedly dart from a marigold. Surprised at such an uncommon appearance, he resolved to examine it with attention; and, to be assured it was no deception of the eye, he placed a man near him, with orders to make a signal at the moment when he observed the light. They both saw it constantly at the same moment. The light was most brilliant on marigolds of an orange or flame colour; but scarcely visible on pale ones. The flash was frequently seen on the same flower two or three times in quick succession, but more commonly at intervals of several minutes: and when several flowers in the same place emitted their light together, it could be observed at a considerable distance. This phenomenon was remarked in the months of July and August at sunset, and for half an hour when the atmosphere was clear; but after a rainy day, or when the air was loaded with vapours, nothing of it was seen. The following flowers emitted flashes, more or less vivid, in this order: 1. The marigold, calendula officinalis. 2. Monk's-hood, tropæolum majus. 3. The orange lily, lilium bulbiferum. 4. The Indian pink, tagetes patula et erecta.

To discover whether some little insects or phosphoric worms might not be the cause of it, the flowers were carefully examined, even with a microscope, without any such thing being found. From the rapidity of the flash, and other circumstances, it may be conjectured that there is something of electricity in this phenomenon. It is well known, that when the pistil of a flower is impregnated, the pollen bursts away by its elasticity, with which electricity may be combined. But M. Haggern, after having observed the flash from the orange lily, the antheræ of which are a considerable space distant from the petals, found that the light proceeded from the petals only; whence he concludes, that this electric light is caused by the pollen, which, in flying off, is scattered on the petals. Whatever be the cause, the effect is singular and highly curious.

Light *house*, a building erected upon a cape or promontory on the sea coast, or upon some rock in the sea, and having on its top in the night time a great fire, or light formed by candles, which is constantly attended by some careful person, so as to be seen at a great distance from the land. It is used to direct the shipping on the coast, that might otherwise run ashore, or steer an improper course, when the darkness of the night and the uncertainty of currents, &c. might render their situation with regard to the shore extremely doubtful. Lamp-lights are, on many accounts, preferable to coal fires or candles; and the effect of these may be increased by placing them either behind glass hemispheres, or before properly disposed glass or metal reflectors, which last method is now very generally adopted. See Beacons.

LIGHTFOOTIA, in botany, so named in honour of John Lightfoot, a genus of the Polygamia Dioecia class and order. Essential character: calyx four-leaved; corolla none: female and hermaphrodite, stigma sessile; berry umbilicated, one-celled, with from three to six seeds. There are three species, all shrubs.

LIGHTNING. It is now universally

allowed, that lightning is really an electrical explosion or phenomenon. Philosophers had not proceeded far in their experiments and inquiries on this subject, before they perceived the obvious analogy between lightning and electricity, and they produced many arguments to evince their similarity. But the method of proving this hypothesis, beyond a doubt, was first proposed by Dr. Franklin, who, about the close of the year 1749, conceived the practicability of drawing lightning down from the clouds. Various circumstances of resemblance between lightning and electricity were remarked by this philosopher, and have been abundantly confirmed by later discoveries, such as the following: Flashes of lightning are usually seen crooked and waving in the air; so the electric spark drawn from an irregular body at some distance, and when it is drawn by an irregular body, or through a space in which the best conductors are disposed in an irregular manner, always exhibits the same appearance. Lightning strikes the highest and most pointed objects in its course, in preference to others, as hills, trees, spires, masts of ships, &c. so all pointed conductors receive and throw off the electric fluid more readily than those that are terminated by flat surfaces. Lightning is observed to take and follow the readiest and best conductor; and the same is the case with electricity in the discharge of the Leyden phial: from whence the Doctor infers, that in a thunder-storm it would be safer to have one's clothes wet than dry. Lightning burns, dissolves metals, rends some bodies, sometimes strikes persons blind, destroys animal life, deprives magnets of their virtue, or reverses their poles; and all these are well-known properties of electricity.

To demonstrate, however, by actual experiment, the identity of the electric fluid with the matter of lightning, Dr. Franklin contrived to bring lightning from the heavens by means of a paper kite, properly fitted up for the purpose, with a long fine wire string, and called an electrical kite, which he raised when a thunder storm was perceived to be coming on: and with the electricity thus obtained, he charged phials, kindled spirits, and performed all other such electrical experiments as are usually exhibited by an excited glass globe or cylinder. This happened in June, 1752, a month after the electricians in France, in pursuance of the method which he had before proposed, had verified the same theory, but without any knowledge of what they had done. The most active of these were Messrs. Dalibard and Delor, followed by M. Mazeas, and M. Monnier.

Nor had the English philosophers been inattentive to this subject. Mr. Canton, however, succeeded in July, 1752; and in the following month Dr. Bevis and Mr. Wilson observed nearly the same appearances as Mr. Canton had done before. By a number of experiments Mr. Canton also soon after observed, that some clouds were in a positive, while some were in a negative state of electricity: and that the electricity of his conductor would sometimes change from one state to the other five or six times in less than half an hour.

How it happens that particular parts of the earth, or the clouds, come into the opposite states of positive and negative electricity, is a question not absolutely determined: though it is easy to conceive that when particular clouds, or different parts of the earth, possess opposite electricities, a discharge will take place within a certain distance; or the one will strike into the other, and in the discharge a flash of lightning will be seen. Mr. Canton queries whether the clouds do not become possessed of electricity by the gradual heating and cooling of the air; and whether air suddenly rarefied may not give electric fire to clouds, and vapours passing through it, and air suddenly condensed receive electric fire from them. Mr. Wilcke supposes, that the air contracts its electricity in the same manner that sulphur and other substances do, when they are heated and cooled in contact with various bodies. Thus, the air being heated or cooled near the earth, gives electricity to the earth, or receives it from it; and the electrified air being conveyed upwards by various means, communicates its electricity to the clouds. Others have queried, whether, since thunder commonly happens in a sultry state of the air, when it seems charged with sulphureous vapours, the electric matter then in the clouds may not be generated by the fermentation of sulphureous vapours with mineral or acid vapours in the air. With regard to places of safety in times of thunder and lightning, Dr. Franklin's advice is, to sit in the middle of a room, provided it be not under a metal lustre suspended by a chain, sitting on one chair, and laying the feet on another. It is still better, he says, to bring two or three mattresses, or beds, into the middle of the room, and folding them double, to place the chairs upon them; for as they are not so good conductors as the walls, the lightning will

not be so likely to pass through them. But the safest place of all is in a hammock hung by silken cords, at an equal distance from all the sides of the room. Dr. Priestley observes, that the place of most perfect safety must be the cellar, and especially the middle of it; for when a person is lower than the surface of the earth, the lightning must strike it before it can possibly reach him. In the fields, the place of safety is within a few yards of a tree, but not quite near it. Beccaria cautions persons not always to trust too much to the neighbourhood of a higher or better conductor than their own body, since he has repeatedly found that the lightning by no means descends in one undivided track, but that bodies of various kinds conduct their share of it at the same time, in proportion to their quantity and conducting power. See Franklin's Letters, Beccaria's Lettre dell' Ellettricessimo, Priestley's History of Electricity, and Lord Mahon's Principles of Electricity.

Lord Mahon observes, that damage may be done by lightning, not only by the main stroke and lateral explosion, but also by what he calls the returning stroke, by which is meant the sudden and violent return of that part of the natural share of electricity which had been gradually expelled from some body or bodies, by the superinduced elastic, electrical pressure of the electrical atmosphere of a thunder-cloud.

The ancient notion of a thunderbolt, or stony mass, falling at the stroke of lightning, seems to have obtained no small degree of force from the modern observations and researches concerning stones which have fallen from the atmosphere. See Stones, *meteoric.* From which it appears, that other substances as well as water are not unfrequently condensed and precipitated from the air, and exhibit the most astonishing degrees of heat and electricity during their condensation.

LIGNUM *vitæ.* The lignum vitæ tree is a native of the West Indies, and the warmer parts of America: there is also a species, a native of the Cape of Good Hope. It is a large tree, rising at its full growth to the height of forty feet, and measuring from fifteen to eighteen inches in diameter; having a hard, brittle, brownish bark, not very thick. The wood is firm, solid, ponderous, very resinous, of a blackish yellow colour in the middle, and a hot aromatic taste. It is so hard as to break the tools which are employed in felling it; and is, therefore, seldom used as firewood, but is of great use to the sugar-planters for making wheels and cogs to the sugar-mills. It is also frequently wrought in bowls, mortars, and other utensils. It is imported into England, in large pieces of four or five hundred weight each, and from its hardness and beauty, is in great demand for various articles in the turnery ware, and for trucks of ship blocks. The wood, gum, bark, fruit, and even the flowers of this plant, have been found to possess medicinal virtues.

LIGULA, in natural history, a genus of the Vermes Intestina. Body linear, equal, long; the fore-part obtuse; the hind-part acute, with an impressed dorsal suture. There are two species, *viz.* L. intestinalis, L. abdominalis; the former is found in the intestines of the merganser and guillemot: about a foot long, and exactly resembling a piece of tape: of the latter there are, at least, eight varieties described as inhabiting the intestines of fish: they are found principally in the mesentery, emaciating the fish they infest, and causing them to grow deformed. When they escape from the body, they penetrate through the skin: they are sometimes solitary, and sometimes gregarious, about half a line thick, and from six inches to five feet long.

LIGUSTICUM, in botany, *lovage*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: fruit oblong, five-grooved on both sides; corolla equal, with involute entire petals. There are eight species, of which L. levisticum, common lovage, has a strong, fleshy, perennial root, striking deep into the ground, composed of many strong fleshy fibres, covered with a brown skin, possessing a hot aromatic smell and taste. The leaves are large, composed of many leaflets, shaped like those of Smallage, but larger and of a deeper green; stems six or seven feet high, large and channelled, dividing into several branches, each terminated by a large umbel of yellow flowers. It is a native of the Alps, of Italy, the South of France, Silesia, &c.

LIGUSTRUM, in botany, *privet*, a genus of the Diandria Monogynia class and order. Natural order of Sepiariæ. Jasmineæ, Jussieu. Essential character: corolla four-cleft; berry four-seeded. There are three species, of which L. vulgare, common privet, is a shrub about six feet in height, branched, the bark of a greenish-ash colour, irregularly sprinkled, with numerous prominent points; branches opposite, the young ones flexible and purplish; leaves opposite, on short pe-

tioles, smooth on both sides; panicle about two inches in length, somewhat pyramidal; corolla white, but soon changes to a reddish-brown. Privet is found wild in most parts of Europe, and in Japan, in woods and hedges; it flourishes best in a moist soil.

LIKE *quantities*, or SIMILAR *quantities*, in algebra, are such as are expressed by the same letters, to the same power, or equally repeated in each quantity; though the numeral co-efficient may be different: thus, $4a$ and $5a$ are like quantities; so also are $3z^2$ and $9z^2$; and likewise $5bdy^2$ $10bdy^2$. But $4a$ and $8b$ are not like quantities; nor are $4a$ and $4a^2$.

LIKE *figures*, the same as SIMILAR *figures*. All like figures have their homologous lines in the same ratio. Like plane figures are in the duplicate ratio, or as the squares of their homologous lines or sides; and like solid figures are in the triplicate ratio, or as the cubes of their homologous sides.

LILIUM, in botany, *lily*, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Lilia, Jussieu. Essential character: corolla six-petalled, bell-shaped, with a longitudinal nectareous line; capsule, the valves connected by cancellated hairs. There are eleven species, with many varieties, L. candidum, common white lily, has a large bulb, from which proceed several succulent fibres; it has a stout, round, upright stem, usually three feet in height; leaves long and numerous, smooth and sessile; flowers white, terminating the stem in a cluster, on short peduncles; petals within of a beautiful shining white, on the outside ridged, and less luminous. Native of the Levant.

LILLY (WILLIAM), in biography, a noted English astrologer, born in Leicestershire in 1602. His father was not able to give him further education than common reading and writing; but young Lilly being of a forward temper, and endued with shrewd wit, he resolved to push his fortune in London, where he arrived in 1620, and, for a present support, articled himself as a servant to a mantua-maker in St. Clement Danes. But in 1624, he moved a step higher, by entering into the service of Mr. Wright, in the Strand, master of the Salters' Company, who not being able to write, Lilly, among other offices, kept his books. On the death of his master, in 1627, Lilly paid his addresses to the widow, whom he married, with a fortune of one thousand pounds.

Being now his own master, he followed the bent of his inclinations, which led him to follow the puritanical preachers. Afterwards turning his mind to judicial astronomy, in 1632 he became pupil, in that art, to one Evans, a profligate Welsh parson; and the next year gave the public a specimen of his skill, by an intimation that the King had chosen an unlucky horoscope for the coronation in Scotland. In 1634, getting a manuscript copy of the "Ars Noticia" of Cornelius Agrippa, with alterations, he drank in the doctrine of the magic circle, and the invocation of spirits, with great eagerness, and practised it for some time; after which he treated the mystery of recovering stolen goods, &c. with great contempt, claiming a supernatural sight, and the gift of prophetical predictions; all which he well knew how to turn to good advantage.

Meanwhile he had buried his first wife, purchased a moiety of thirteen houses in the Strand, and married a second wife, who, joining to an extravagant temper a termagant spirit, which he could not lay, made him unhappy, and greatly reduced his circumstances.

With this uncomfortable yoke-mate he removed, in 1636, to Hersham, in Surrey, where he staid till 1641; when, seeing a prospect of fishing in troubled waters, he returned to London. Here, having purchased several curious books in this art, which were found on pulling down the house of another astrologer, he studied them incessantly, finding out secrets contained in them, which were written in an imperfect Greek character; and, in 1644, he published his "Merlinus Anglicus," an almanack, which he continued annually till his death, and several other astrological works, devoting his pen, and other labours, sometimes to King Charles's party, and at others to that of the parliament, but mostly to the latter, raising his fortune by favourable predictions to both parties, at one time by presents, and at others by pensions. Thus, in 1648, the council of state gave him in money fifty pounds, and a pension of one hundred pounds per annum, which he received for two years, and then resigned it on some disgust.

By his advice and contrivance, the King attempted several times to make his escape from confinement; he procured and sent the aqua fortis, and files to cut the iron bars of his prison windows at Carisbrook Castle; but still advising and writing for the other party at the same time. Meanwhile he read public lectures on astrology in 1648 and 1649, for the improvement of young students in that art;

and, in short, plied his business so well, that, in 1651 and 1652, he laid out two thousand pounds for lands and a house at Hersham.

During the siege of Colchester, he and Booker were sent for thither to encourage the soldiers; which they did by assuring them that the town would soon be taken; which proved true in the event.

Having, in 1650, written publicly that the parliament should not continue, but a new government arise; agreeably to which, in his almanack for 1653, he asserted that the parliament stood upon a ticklish foundation, and that the commonalty and soldiery would join together against them. Upon which he was summoned before the committee of plundered ministers; but receiving notice of it before the arrival of the messenger, he applied to his friend Lenthal, the Speaker, who pointed out the offensive passages. He immediately altered them, attended the committee next morning, with six copies printed, which six alone he acknowledged to be his, and by that means came off with only thirteen days custody by the serjeant at arms. This year he was engaged in a dispute with Mr. Thomas Gataker.

In 1665, he was indicted at Hicks's Hall for giving judgment upon stolen goods, but was acquitted. In 1659, he received from the King of Sweden a present of a gold chain and medal, worth about fifty pounds, on account of his having mentioned that monarch with great respect in his almanacks of 1657 and 1658.

After the Restoration in 1660, being taken into custody, and examined by a committee of the House of Commons, touching the execution of Charles I., he declared that Robert Spavin, then secretary to Cromwell, dining with him soon after the fact, assured him it was done by Cornet Joyce. The same year he sued out his pardon, under the broad seal of England, and afterwards continued in London till 1665, when, upon the raging of the plague there, he retired to his estate at Hersham. Here he applied himself to the study of physic, having, by means of his friend Elias Ashmole, procured from Archbishop Sheldon a licence to practise it, which he did, as well as astrology, from thence till the time of his death. In October, 1666, he was examined before a committee of the House of Commons, concerning the fire of London, which happened in September that year. A little before his death he adopted for his son, by the name of Merlin Junior, one Henry Coley, a tailor by trade; and at the same time gave him the impression of his almanack, which had been printed for thirty-six years successively. This Coley became afterwards a celebrated astrologer, publishing in his own name almanacks and books of astrology, particularly one entitled "A Key to Astrology."

Lilly died of the palsy in 1681, at seventy-nine years of age; and his friend Mr. Ashmole placed a monument over his grave in the church of Walton upon Thames.

Lilly was the author of many works. His "Observations on the Life and Death of Charles, late King of England," if we overlook the astrological nonsense, may be read with as much satisfaction as more celebrated histories, Lilly being not only very well informed, but strictly impartial. This work, with the lives of Lilly and Ashmole, written by themselves, were published in one volume 8vo. in 1774, by Mr. Burman. His other works were principally as follow:

1. Merlinus Anglicus, junior. 2. Supernatural Sight. 3. The White King's Prophecy. 4. England's prophetical Merlin: all printed in 1644. 5. The starry Messenger, 1645. 6. Collection of Prophecies, 1646. 7. A Comment on the White King's Prophecy, 1646. 8. The Nativities of Archbishop Laud and Thomas Earl of Stafford, 1646. 9. Christian Astrology, 1647: upon this piece he read his lectures in 1648, mentioned above. 10. The third Book of Nativities, 1647. 11. The World's Catastrophe, 1647. 12. The Prophecies of Ambrose Merlin, with a Key, 1647. 13. Trithemius, or the Government of the World by presiding Angels, 1647. 14. A Treatise of the Three Suns seen in the Winter of 1647, printed in 1648. 15. Monarchy or no Monarchy, 1651. 16. Observations on the Life and Death of Charles, late King of England, 1651; and again in 1657, with the title of Mr. William Lilly's true History of King James and King Charles I., &c. 17. Annus Tenebrosus, or the Black Year. This drew him into the dispute with Gataker, which Lilly carried on in his Almanack in 1654.

LIMAX, in natural history, the *slug*. Body oblong, creeping, with a fleshy kind of shield above, and a longitudinal flat dish beneath; aperture placed on the right side, within the shield; four feelers, situate above the mouth, with an eye at the tip of each of the larger ones. There are sixteen species; L. lævis: body black, and almost without wrinkles, found among

the moss late in the autumn, five lines long; body glossy, with undulate, transverse striæ on the shield; narrower and not so much wrinkled as the next. L. ater; body black and furrowed with deep wrinkles; of this species there are five or six varieties, differing in colour and size; the dusky-brown with a yellowish mouth, a streak on each side; is found in woods, meadows, fields, and gardens; is from one and a half to five inches long; crawls slowly, and leaves a slime upon whatever it passes over. L. alba, is white, and is found in woods and groves; from three to five inches long. L. hyalinus; body hyaline; feelers obsolete, with a brown line reaching from the feelers to the shield; inhabits mossy places, and is very destructive to the young shoots of kidney-beans; belly with numerous interrupted wrinkles. L. agrestes; body whitish, with black feelers: five varieties, of which some have the power of secreting a large quantity of mucous from the under surface, and forming it into a thread like a spider's web; by this means it often suspends itself, and descends from the branches of trees, or any height it had crawled up to. It is found in England, in gardens, pastures, and groves, from May till December. One of the varieties of this species is that which has been recommended to be swallowed by consumptive persons; it is half an inch long, and when touched it sticks as if dead to the fingers.

LIME, or calcareous earth, predominates in most stones which are soft enough to be scratched with a knife. These are chalk, lime-stone, marble, spars, gypsum, or plaster-stone, and various others. As the lime is most frequently combined with carbonic acid, it is usual for mineralogists to drop a small quantity of nitric acid upon the stones they are desirous of classing; and if they froth by the escape of the acid, they conclude that lime enters into the composition. To obtain pure calcareous earth, powdered chalk must be repeatedly boiled in water, which will deprive it of the saline impurities it frequently contains. It must then be dissolved in distilled vinegar, and precipitated by the addition of concrete volatile alkali. The precipitate, when well washed and dried, will consist of lime united to carbonic acid; the latter of which may be driven off by heat, if necessary.

If chalk, marble, lime-stone, spar, or any other specimens of this earth, containing carbonic acid, be exposed to continued ignition, they give out carbonic acid and water, to the amount of nearly half their weight. The remainder, consisting chiefly of lime, has a strong tendency to combination, and attracts water very powerfully. The addition of water to lime produces a very considerable heat, attended with noise, and agitation of the parts, which break asunder; a considerable vapour arises, which carries up with it part of the lime; and a phosphoric light is seen, if the experiment be made in the dark. Lime thus saturated with water is said to be slaked. Water dissolves about one five-hundredth part of its weight of lime, and is then called lime-water. This solution has an acrid taste, and turns syrup of violets to a green colour. If lime-water be exposed to the open air, the lime attracts carbonic acid, and is by this means converted into chalk; which, not being soluble in water, forms a crust on the surface, formerly called cream of lime, which, when of a certain thickness, breaks, and falls to the bottom: and in this way the whole of the lime will in time be separated. If the fire have been too violent in the burning of lime, the stones become hard, sonorous, and incapable of absorbing water with the requisite degree of avidity. This effect seems to arise from part of the calcareous earth having entered into fusion with the clay, flint, or other contaminating earths, with which it forms a glass that covers and defends the rest.

The paste of lime and water, called mortar, has a degree of adhesion and ductility, though much less than clay. When dry, it is more or less friable, like chalk. A mixture of sand, or broken earthen vessels, greatly increases its firmness, which it seems to effect by rendering it more difficult for the parts to be removed with respect to each other. When mortar is left to dry by the gradual evaporation of its superfluous water, it is very long before it obtains its utmost degree of firmness. But if dry quick-lime be mixed with mortar, it gradually absorbs the superfluous water, and the mass becomes solid in a very short time. See Mortar.

Lime has an affinity for tannin, whence it is probable that a portion of it is retained in tanned leather, perhaps not to the improvement of its quality. It has an edulcorative power with respect to animal oils, by combining with the putrid gelatine in them; but its action on them in forming a soap is too strong to admit of its being used for this purpose with ad-

vantage, unless in small quantities. Feathers, however, may be very conveniently cleaned, by steeping three or four days in strong lime-water, and afterward washing and drying them.

Though infusible in the strongest heats of our furnaces, it is nevertheless a very powerful flux with regard to mixtures of the other earths. These are all fusible by a proper addition of lime. Compounds are still more fusible; for any three of the five well-known earths may be fused into perfect glass, if they be mixed together in equal portions, provided the calcareous be one of them.

The earthy part of animals is chiefly, if not altogether, calcareous: in most cases it is united with phosphoric acid, but frequently with the carbonic.

LIME-*stone.* The native indurated carbonate of lime. It is usually more or less bluish from iron, and of a granulated fracture; and it is connected with lime by ignition in lime-kilns, for the purpose of making mortar. See LIME; also MORTAR.

LIMEUM, in botany, a genus of the Heptandria Digynia class and order. Natural order of Holoraceæ. Portulaceæ, Jussieu. Essential character: calyx five-leaved; petals five, equal; capsule globular, two-celled. There are three species, all natives of the Cape of Good Hope.

LIMIT, in a restrained sense, is used by mathematicians for a determinate quantity to which a variable one continually approaches; in which sense the circle may be said to be the limit of its circumscribed and inscribed polygons. In algebra, the term limit is applied to two quantities, one of which is greater, and the other less, than another quantity; and in this sense it is used in speaking of the limits of equations, whereby their solution is much facilitated.

Let any equation, as $x^3 - p x^2 \times q x - r = o$ be proposed; and transform it into the following equation:

$$\left.\begin{array}{r} y^3 + 3 e y^2 + 3 e^2 y + e^3 \\ - p y^2 - 2 p e y - p e^2 \\ + q y + q e \\ - r \end{array}\right\} = o.$$

Where the values of y are less than the respective values of x, by the difference e. If you suppose e to be taken such as to make all the coefficients of the equation of y positive, *viz.* $e^3 - p e^2 + q e - r$, $3 e^2 - 2 p e + q$, $3 e - p$; then, there being no variation of the signs in the equation, all the values of y must be negative; and consequently the quantity e, by which the values of x are diminished, must be greater than the greatest positive value of x; and, consequently, must be the limit of the roots of the equation $x^3 - p x^2 + q x - r = o$.

It is sufficient, therefore, in order to find the limit, to inquire what quantity substituted for x, in each of these expressions $x^3 - p x^2 + q x - r$, $3 x^2 - 2 p x + q$, $3 x - p$, will give them all positive; for the quantity will be the limit required.

Having found the limit that surpasses the greatest positive root, call it m. And if you assume $y = m - x$, and for x substitute $m - y$, the equation that will arise will have all its roots positive; because m is supposed to surpass all the values of x, and consequently $m - x$ $(= y)$ must always be affirmative. And, by this means, any equation may be changed into one that shall have all its roots affirmative.

Or, if $-n$ represent the limit of the negative roots, then by assuming $y = x + n$ the proposed equation shall be transformed into one that shall have all its roots affirmative; for $+n$ being greater than any negative value of x, it follows that $y = x + n$ must be always positive.

What is here said of the above cubic equation, may be easily applied to others; and of all such equations, two limits are easily discovered, *viz.* o, which is less than the least; and e, found as above, which surpasses the greatest root of the equation. But besides these, other limits still nearer the roots may be found; for the method of doing which, the reader may consult Maclaurin's Algebra.

LIMITATION, a certain time prescribed by statute, within which an action must be brought, which is generally twofold; first in writs, by several acts of parliament, and, secondly, to make a title to any inheritance, and that is by the common law.

On penal statutes, all actions, suits, bills, indictments, or informations, for any forfeiture limited to the king, his heirs or successors only, shall be brought within two years after the offence committed, and not after. All such actions, &c. except the statutes of tillage, which give the penalty to the king and a common informer, are limited to one year next after the offence committed; and if not sued for by the informer, they may be sued for by the king, any time within the two years, after that year is ended: and where a shorter time is limited by any penal statute, the prosecution must be within that time. 31 Eliz. c. 5.

All actions of trespass, of assault, battery, wounding, imprisonment, or any of

them, are to be commenced within four years next after the cause of such actions or suits, and not after: 21 James I. c. 16. All actions of trespass, *quare clausum fregit;* all actions of trespass, detinue, trover, and replevin; all actions of account, and upon the case, (other than such accounts as concern the trade of merchandise between merchant and merchant); all actions of debt, grounded upon any lending, or contract without specialty (that is, not being by deed or under seal); all actions of debt for arrearages of rent; and all actions of assault, menace, battery, wounding, and imprisonment, shall be commenced within the time and limitation as followeth, and not after: that is to say, the said actions upon the case (other than for slander), and the said actions for account, and the said actions for trespass, debt, detinue, and replevin, and the said action for trespass *quare clausum fregit*, within six years after the cause of such action: 21 James I. c. 16. In all these statutes there is an exception in relation to infants, lunatics, and femes coverts, allowing them a further time after they are in a situation which enables them to sue. As to the exception with respect to merchants' accounts, it extends to actions on accounts current only, in which the giving credit on one side is an acknowledgment of the debt on the other; but when the account is settled between merchant and merchant, it must be sued for like any other debt; and if all the articles are on one side, the account is not taken out of the statute. An acknowledgment of the debt prevents the operation of the statute of limitations, and also a payment upon account; but as it is convenient that suits should not be delayed so long that vouchers cannot be produced, settlements should regularly be enforced. A writ also may be sued out to save the statute of limitation, as it is called, and though never sued, yet, if it is regularly entered, and continued upon the record, the suit may be effectually prosecuted long after, and being commenced within time, the action may be maintained out. This is in conscience rather a mode of evading the statute. It is generally considered as an unfair defence to rely upon the statute, when the party has the actual means of knowing whether the debt is due, and therefore a very slight acknowledgment removes the objection to the suit.

LIMNING, the art of painting in water colours, in contradistinction to painting which is done in oil colours. See PAINTING

LIMODORUM, in botany, a genus of the Gynandria Diandria class and order. Natural order of Orchideæ. Essential character: nectary one-leafed, concave, pedicelled, within the lowest petal. There are thirteen species.

LIMONIA, in botany, a genus of the Decandria Monogynia class and order. Essential character: calyx five-parted; petals five; berry three-celled; seeds solitary. There are seven species, of which L. pentaphylla, five-leaved limonia, is an elegant fragrant shrub, very common in most uncultivated lands in Coromandel, but chiefly under large trees, where birds have dropped the seeds. It flowers all the year. The whole plant, when drying in the shade, diffuses a pleasant permanent scent; the flowers are exquisitely fragrant; birds eat the berries greedily.

LIMOSELLA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Preciæ. Lysimachiæ, Jussieu. Essential character: calyx five-cleft; corolla five-cleft, equal; stamina approximating by pairs; capsule one-celled, two-valved, many-seeded. There are two species, *viz.* L. aquatica, common mud-wort, or bastard plantain; and L. diandria.

LINCONIA, in botany, a genus of the Pentandria Digynia class and order. Estial character; petals five, with a nectareous excavation at the base; capsule two-celled. There is but one species, *viz.* L. alopecuroidea, a native of the Cape of Good Hope, in watery places among the mountains.

LINDERA, in botany, so named from J. Linder, a Swede, a genus of the Hexandria Monogynia class and order. Essential character: corolla six-petalled; capsule. There is only one species, *viz.* L. umbellata, a native of Japan.

LINDERNIA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx five-parted; corolla ringent, with the upper lip very short; stamina the two lower with a terminating tooth, and a sublateral anther; capsule one-celled. There are three species.

LINE, in geometry, a quantity extended in length only, without any breadth or thickness. It is formed by the flux or motion of a point. See FLUXION.

LINES in perspective, are, 1. Geometrical line, which is a right line drawn in

any manner on the geometrical plane. 2. Terrestrial line, or fundamental line, is a right line, wherein the geometrical plane, and that of the picture or draught, intersect one another, formed by the intersection of the geometrical plane, and the perspective plane. 3. Line of the front, is any right line parallel to the terrestrial line. 4. Vertical line, the common section of the vertical and of the draught. 5. Visual line, the line or ray imagined to pass from the object to the eye. 6. Line of station, according to some writers, is the common section of the vertical and geometrical planes. 7. Objective line, the line of an object from whence the appearance is sought for in the draught or picture.

Lines, in dialling, are, 1. Horizontal line, the common section of the horizon and the dial plane. See Dialling. 2. Horary lines, or hour-lines, the common intersections of the hour-circles of the sphere, with the plane of the dial. See Horary. 3. Substylar line, that line on which the style or cock of a dial is duly erected, and the representation of such an hour circle as is perpendicular to the plane of that dial. 4. Equinoctial line, the common intersection of the equinoctial and plane of the dial.

Line *of measures*, is used by Oughtred, to denote the diameter of the primitive circle in the projection of the sphere in plano, or that line in which the diameter of any circle to be projected falls. In the stereographic projection of the sphere in plano, the line of measures is that line in which the plane of a great circle perpendicular to the plane of the projection, and that oblique circle which is to be projected, intersects the plane of the projection; or it is the common section of a plane passing through the eye point and the centre of the primitive at right angles to any oblique circle which is to be projected, and in which the centre and pole of such circle will be found.

Line *of direction* on the earth's axis, in the Pythagorean system of astronomy, the line connecting the two poles of the ecliptic and of the equator, when they are projected on the plane of the former.

Line *of direction*, in mechanics, that wherein a body actually moves, or would move, if it were not hindered. It also denotes the line that passes through the centre of gravity of the heavy body to the centre of the earth, which must also pass through the fulcrum, or support of the heavy body, without which it would fall.

Line *of gravitation*, of any heavy body, a line drawn through its centre of gravity, and according to which it tends downwards.

Line *of the swiftest descent*, of a heavy body, is the cycloid. See Cycloid.

Lines *on the plane scale*, are the line of chords, line of sines, line of tangents, line of secants, line of semitangents, line of leagues; the construction and application of which, see under Mathematical Instruments, Sailing, &c.

Lines *on Gunter's scale*, are the line of numbers, line of artificial sines, line of artificial tangents, line of artificial versed sines, line of artificial sines of rhumbs, line of artificial tangents of the meridian line, and line of equal parts; for the construction and application whereof, see Gunter's *scale*.

Lines *of the sector*, are the line of equal parts, or line of lines, line of chords, line of sines, line of tangents, line of secants, line of polygons, line of numbers, line of hours, line of latitudes, line of meridians, line of metals, line of solids, line of planes; for the construction and use whereof, see Sector.

Lines, in fortification, are those of approach, capital, defence, circumvallation, contravallation, of the base, &c. See Approach, &c.

To Line *a work*, signifies to strengthen a rampart with a firm wall; or to encompass a parapet or moat with good turf, &c.

Line, in the art of war, is understood of the disposition of an army, ranged in order of battle, with the front extended as far as may be, that it may not be flanked. See Army.

Line *of battle*, is also understood of the disposition of a fleet on the day of engagement, on which occasion the vessels are usually drawn up as much as possible in a straight line, as well to gain and keep the advantage of the wind, as to run the same board.

Line, *ship of the*, a vessel large enough to be drawn up in the line, and to have a place in a sea-fight. See Ship.

Line, in fencing, that part of the body opposite to the enemy, wherein the shoulders, the right arm, and the sword, ought always to be found; and wherein are also to be placed the two feet, at the distance of eighteen inches from each other. In which sense a man is said to be in his line, or to go out of his line, &c.

Line *of the synodical*, in reference to some theories of the moon, is a right line supposed to be drawn through the centres of the earth and sun; and, if it be produced quite through the orbits, it is

called the *line of the true syzygies*: but a right line imagined to pass through the earth's centre, and the mean place of the sun, is called the *line of the mean syzygies*.

Line, in genealogy, a series or succession of relations in various degrees, all descending from the same common father. Direct line, is that which goes from father to son; being the order of ascendants and descendants. Collateral line, is the order of those who descend from some common father related to the former, but out of the line of ascendants and descendants: in this are placed uncles, aunts, cousins, nephews, &c.

Line was also formerly a French measure, containing the twelfth part of an inch, or the hundred and forty-fourth part of a foot. Geometricians conceive the line, notwithstanding its smallness, to be subdivided into six points.

Lines, in music, the name of those strokes drawn horizontally on a piece of paper, on and between which the characters and notes of music are disposed: their number is commonly five; when another is added, for one, two, or more notes, it is called a ledger-line.

Lines, in heraldry, the figures used in armories, to divide the shield into different parts, and to compose different figures. These lines, according to their different forms and names, give denomination to the pieces or figures which they form, except the straight or plain lines.

LINEAR *numbers*, in mathematics, such as have relation to length only; such is a number which represents one side of a plane figure. If the plane figure be a square, the linear number is called a root.

Linear *problem*, that which may be solved geometrically, by the intersection of two right lines. This is called a simple problem, and is capable but of one solution.

LINEN, in commerce. The linen manufacture was probably introduced into Britain with the first settlements of the Romans. The flax was certainly first planted by that nation in the British soil. The plant itself indeed appears to have been originally a native of the east. The woollen-drapery would naturally be prior in its origin to the linen, and the fibrous plants from which the threads of the latter are produced, seem to have been first noticed and worked by the inhabitants of Egypt. In Egypt, indeed, the linen manufacture appears to have been very early; for even in Joseph's time it had risen to a considerable height. From the Egyptians the knowledge of it proceeded probably to the Greeks, and from them to the Romans. Even at this day the flax is imported among us from the eastern nations; the western kind being merely a degenerate species of it. In order to succeed in the linen manufacture, one set of people should be confined to the ploughing and preparing the soil, sowing and covering the seed, to the weeding, pulling, rippling, and taking care of the new seed, and watering and dressing the flax till it is lodged at home: others should be concerned in the drying, breaking, scutching, and heckling the flax, to fit it for the spinners; and others in spinning and reeling it, to fit it for the weaver: others should be concerned in taking due care of the weaving, bleaching, beetling, and finishing the cloth for the market. It is reasonable to believe, that if these several branches of the manufacture were carried on by distinct dealers in Scotland and Ireland, where our home-made linens are manufactured, the several parts would be better executed, and the whole would be afforded cheaper, and with greater profit.

LING, in ichthyology, the cirrated gadus with two black fins, and with the upper jaw longest; a fish called by authors asellus longus. See Gadus.

LINGUATALA, in natural history, a genus of the Vermes Intestina class and order. Body depressed, oblong; mouth placed before, surrounded with four passages. There is but a single species, *viz.* L. serrata, inhabiting the lungs of the hare.

LINGUIFORM, in Nat. Hist. tongue-shaped; linear, with the extremity obtusely rounded.

LINNÆA, in botany, so named in honour of the celebrated Linnæus, a genus of the Didynamia Angiospermia class and order. Natural order of Aggregatæ. Caprifoliæ, Jussieu. Essential character: calyx double, of the fruit two-leaved, of the flower five-parted, superior; corolla bell-shaped; berry dry, three-celled. There is but one species, *viz.* L. borealis, two-flowered linnæa, a native of the north of Europe.

LINNÆUS, Charles, (*Carl von Linné*) the most eminent naturalist of this age, and the founder of modern botany, was born in 1707, at Rashult, in the province of Smaland, in Sweden, where his father resided as assistant minister to the parish of Stenbrohult. The father, Nils, who was the son of a peasant named Bengtson, had, on going into orders, assumed the name of Linnæus, which was therefore the

proper name of young Charles. Nils was attached to the culture of his garden, which he had stocked with some of the rarer plants in that climate, and it is to the delight with which this spot inspired Charles, from his earliest childhood, that he himself ascribes his botanical passion. A remarkable quickness of sight, a hardy constitution, and a retentive memory, gave him the corporeal and mental requisites for indulging his disposition, and thus he was marked out for a naturalist almost from his cradle. His father intending him for his own profession, sent him to the grammar school at Wexio at the age of ten, whence he was removed at the age of seventeen years to the higher seminary, called the gymnasium. In neither of these situations was he distinguished for his proficiency in the ordinary studies of a literary education; but he made a rapid progress in the knowledge of plants, which he ardently pursued, both by frequent excursions in the fields, and by the unwearied perusal of such books on the subject as he was able to procure. When his father, in 1726, came to Wexio for the purpose of inquiring into his improvement, he was much mortified to find his son declared utterly unfit for a learned profession by tutors, who advised that he should be put to some handicraft trade. In this perplexity he applied to the physician, Rothman, who was also lecturer in natural philosophy, the only branch of academic study for which young Linnæus had shewn any inclination. This person discovered in him talents, which, though not fitted to make him a theologian, were not ill adapted for another profession, and he proposed that of physic. As the father's circumstances were very narrow, Rothman offered to take the youth gratuitously into his own house during the year that remained for him to finish his course in the gymnasium; he also gave him private instructions in physiology, and put him into a systematic method of studying botany, according to Tournefort's arrangement, which was then looked upon as the most scientific.

In 1727, Linnæus was entered at the University of Lund; he lodged in the house of Stobœus, a physician, who possessed a good library and museum of natural history. He appears here to have paid for his entertainment by various little services, such as that of forming a hortus siccus, and acting as an amanuensis. It was, however, only by accident that his host came to know the extent of his studious ardour. The mother of Stobœus having observed that the candle in his chamber was burning at unseasonable hours, was induced, through fear of fire, to complain of it to her son. Stobœus thereupon entered his chamber at a late hour, and found him diligently occupied with reading. Struck with this proof of his thirst after improvement, he gave Linnæus the free use of his library, and admission to his table. The advice of Rothman, however, caused the young student, in 1728, to quit Lund, and to remove to Upsal, for the sake of the superior advantages it afforded. His father advanced him the sum of about eight pounds sterling, which he was informed was all the paternal assistance he was to expect. Thus he was turned out upon the world while yet but a learner in the profession by which he was to get his bread. His little patrimony was soon exhausted, and he was reduced to depend upon chance for a meal. Unable to pay even for the mending of his shoes, he was obliged to patch them himself with folded paper, and notwithstanding his sanguine temper, he could not forbear repenting that he had left his comfortable situation at Lund.

At length, in the autumn of 1729, as he was intently examining some plants in the university garden, he was accosted by Dr. Olof Celsius, professor of divinity, and an eminent naturalist, who was then engaged in preparing a work on the plants mentioned in the scripture. A little conversation soon apprised him of the extraordinary botanical acquisitions of the student, and perceiving his necessitous circumstances, he took him to live in his own house. It was in this year that an account in the Leipsic Commentaries of Vaillant's Treatise on the Sexes of Plants, engaged him in an accurate examination of the stamina and pistils of flowers, and finding a great variety of structure, he conceived the idea of a new systematic arrangement, founded on the sexual parts. He drew up a treatise on this principle, which was shewn to Celsius, and by him to the botanical professor, Rudbeck, who had the liberality to bestow on it his warmest approbation. As the professor's advanced age made him desirous of a deputy in the office of lecturing, Linnæus, in 1730, was appointed to this office, and was also taken by Rudbeck into his own house as tutor to his sons.

The court of Sweden having issued an order that the academy at Upsal should

send a proper person to travel through Lapland, Linnæus, who had a strong inclination to visit that country, was chosen for the office. He set out in May, 1732, very slenderly provided as a scientific traveller, all his baggage with himself being carried on a single horse. This tour would have been much more interesting to science had it been taken when he was further advanced in his studies, and better equipped for making observations. Its chief fruits were a "flora lapponica," and some curious medical and economical facts.

Having learnt the art of assaying metals at the mines of Calix, he gave lectures on that subject, and mineralogy in general, after his return. He improved himself in this br nch of knowledge by a visit to the mining country round Fahlun, at the end of 1733. He found, however, that a doctor's degree would be necessary to his further advancement, and in order to obtain this, money was necessary. For this purpose he was advised by a friend to turn his thoughts towards a matrimonial connection with some lady of fortune, and having an introduction to the family of Moræus, the town physician of Fahlun, he ventured to make his addresses to his eldest daughter Elizabeth, and was favourably received. His indigent circumstances gave him little hopes of obtaining the father's consent; but, to his surprise, he only required a delay until his exertions should open a path to a comfortable settlement. Linnæus therefore resolved to travel in quest of fortune and a degree, and having accumulated his little savings, to which were added those of his faithful Elizabeth, he set out for Holland in the spring of 1735.

At Harderwyck, as the cheapest university, he took the degree of doctor of physic, maintaining for his thesis, "Nova Hypothesis Febrium Intermittentium." He visited Leyden and Amsterdam, and was particularly noticed by Dr. John Frederic Gronovius, who, upon being shewn in manuscript the first sketch of the "Systema Naturæ," requested it might be printed at his own expense. This was accordingly done at Leyden, in 1735, in a tabular form, occupying twelve folio pages. By the advice of Gronovius he waited on Boerhaave, who, on conversing with him, became sensible of his singular attainments in botany, and advised him to remain in Holland. Munificence was not among that great man's excellençies, and a verbal message, by way of introduction to Burmann at Amsterdam, was the principal favour that Linnæus received from him. That eminent botanist, who was there engaged on his work on the plants of Ceylon, took the Swede into his house, and treated him with great liberality. His library and collections were of much use to Linnæus, who there published his excellent work, the "Fundamenta Botanica," the basis of his system. While he was in this situation, Mr. Clifford, an opulent merchant of Amsterdam, who had a fine garden of exotics, having heard of the merit of Linnæus from Boerhaave, prevailed upon Burmann to part with him, and took him to his country house at Hartecamp, near Haerlem.

In 1736 Linnæus, at Mr. Clifford's expence, paid a visit to England. There were at that time few distinguished botanists in this country, and Dillenius was the person whom he was most desirous of seeing; Linnæus went to him at Oxford, and at first met with a cool reception, the old botanist having been offended with some of his innovations: after a little conversation, however, he liked him so well, that he detained him a month, and strongly urged him to take up his abode at Oxford, and share his salary as professor. Dr. Shaw, the traveller, Martyn, Miller, and Collinson, also showed him much civility; but Sir Hans Sloane did not pay the attention to him which might have been expected from such a votary of natural history. Linnæus returned to Holland, enriched with many new plants for Clifford's garden, the description of which, under the title of "Hortus Cliffortianus," appeared in a splendid publication in 1737, drawn up by him, and arranged according to his new system. He had already, in the same year, presented to the botanical world the essence of that system in the first edition of his "Genera Plantarum."

In the year 1738, having received intelligence that he was in danger of being rivalled in his pretensions to his mistress, by the influence another had obtained with her father, he thought it necessary no longer to delay his return. As soon, therefore, as he was able, after his recovery from a severe illness, he took his way through the Low Countries to Paris. At that capital he had recommendations to the Jussieus, who received him with great kindness, and made him known to Reaumur and other eminent naturalists, and showed him all the curiosities of the place. At a visit to the Academy of Sci-

ences, it was announced to him that he was elected a corresponding member. The attachment of the French to the method of their eminent countryman, Tournefort, was unfavourable to the reception of the Linnæan system among them, but he had reason to be satisfied with the personal attention which he experienced. At Rouen he embarked for Sweden, where, on his arrival, he immediately proceeded to Fahlun, and was formally betrothed to the object of his affections. In the month of September he went to Stockholm, in order to try his fortune as a physician; but he found that his fame as a botanist had either not reached thither, or was of no service to him as a practitioner. At length, however, he obtained the confidence of some young men of rank, who gave him considerable employment. A private meeting of men of science being formed in the capital, Linnæus was made an associate, and had the precedency for the first three months: this institution was the parent of the Royal Academy of Stockholm. His reputation made him known to Count Tessin, Marshal of the Diet, by whose influence a salary was conferred upon him, with the condition of his giving public lectures on botany in the summer, and on mineralogy in the winter. That nobleman also procured for him the post of Physician to the Navy, and gave him a general invitation to his table. His affairs now wore so prosperous an aspect, that he would no longer delay his union with his betrothed Anna-Elizabeth Moræa, and they married in June, 1739.

The death of Rudbeck, professor of botany at Upsal, in 1740, opened to Linnæus a prospect of the literary situation which had always been the object of his wishes, in which he might devote himself entirely to the improvement of natural history, uninterrupted by the cares of medical practice. He had, however, a competitor, Rousen, his ancient rival and antagonist, whose superior academical claims obtained the preference. But the resignation of Rouberg, the medical professor, having made another vacancy, that chair was given to Linnæus, with the condition that he and Rousen should divide the business of the two professorships between them; and to the former were allotted the departments of the botanic garden, materia medica, simiology, diætetics, and natural history in general. Before his removal to Upsal, he was engaged by the States to travel through the Southern provinces of Sweden, for the purpose of collecting such information as might tend to the improvement of agriculture and manufactures. In this tour he was accompanied by six pupils, and he performed the task to the satisfaction of the States: its result was printed. He entered on his professorship in the autumn of 1741, on which occasion he pronounced a Latin oration "On the necessity of travelling one's own country." His own past exertions in this respect rendered it a very entertaining and interesting composition. In the same year he made the tour of the islands of Oeland and Gothland, by order of the States; and in subsequent years he travelled, by the same requisition, through West Gothland and Scania. Exclusive of these exertions his abode was henceforth fixed at Upsal, and the remaining history of his life is only that of his literary and scientific labours, and of the honours and distinctions which were accumulated upon him.

One of his first cares was to improve and new model the academic garden. He procured the erection of several new buildings, arranged the plants according to his own system, and founded a museum of natural history in part of the green-house. In 1745 he published the first edition of his "Flora Succica," an admirable specimen of a local catalogue, and the pattern of all those which have since been made upon the Linnæan system. In the next year appeared his "Fauna Succica," or Catalogue of the Animal Kingdom in Sweden, arranged also according to his own method. In the numerous and difficult class of insects he adopted an entirely new method of arrangement, which has been adopted by most later entomologists. His merits, indeed, with respect to this class of natural productions, stands next to those with respect to the vegetable productions. The same accurate inspection was requisite in both, and from the immense number of subjects in each, it was equally necessary in both to search out for minute diversities, whereon to found an artificial classification. The credit he was now acquiring in his own country appeared in his election to the post of Secretary to the Academy of Sciences at Upsal, in a medal of him struck at the expence of some noblemen in 1746, and in his nomination by the king to the rank and title of archiater, in 1747. He now also began to exert his influence in procuring the mission of his young disciples to different parts of the globe, in order to make discoveries in na-

tural history and œconomy; a circumstance by which he is distinguished above all other naturalists, and which has redounded equally to his own glory, and to the public advantage. The travels of Kalm, of Osbeck, of Hasselquist, of Lofling, were the fruits of his zeal in this point. To Linnæus may also be ascribed that curious collection of treatises, which, under the name of "Amænitates Academicæ," began to be published in the year 1749, and were continued to a number of volumes. They are academical theses, held under Linnæus in his professional capacity, and may be regarded as containing his own doctrines and opinions on most of the points discussed.

The work of Linnæus, which Haller terms his "Maximus Opus et Æternum," appeared in 1753. It was the "Species Plantarum," in two volumes, 8vo. containing a description of every known plant, arranged according to his sexual system. The description, however, is independent of any system, as being founded on the essential character of each species, with a further reference to the generic description given in the "Genera Plantarum." In this publication Linnæus first introduced his admirable invention of trivial names, or epithets taken from the most prominent specific mark of the subject, or from some other characteristic circumstance. The specific descriptions are given in the precise form of a definition, with a great variety of terms of his own invention, simple and compound, forming, as it were, a new botanical language. If in these terms he has not aimed at a classical purity, he has in general formed them upon correct analogy; and it cannot be denied that they are excellently adapted for their purpose. In the same year he was created by the king a Knight of the Polar Star, an honour which had never before been conferred on a literary character. His elevation to the rank of nobility, by the king's sign manual, took place eight years after, in 1761, but antedated 1757, and from that time he wrote his name C. Von Linné. In the mean time honours of a literary kind had been accumulating upon him from foreign countries. Besides many learned societies of inferior rank, he was aggregated to the Imperial Academy, to the Societies of Berlin, London, and to the Academy, and finally was nominated one of the eight foreign members of the Academy of Sciences of Paris, being the first Swede that had obtained that distinction. The remote city of Upsal was visited by many strangers, attracted by his reputation, which extended throughout Europe, and the number of students in its university was doubled. His correspondence included almost all the eminent cultivators of natural history; and he was continually receiving from all parts tributes of books, plants, and specimens, which enabled him to complete his vast plan of carrying a new systematic arrangement through every department of nature. This he effected by the completion of his great work, "Systema Naturæ," which had grown in successive editions from a few tables to two, and finally, to three volumes, and received his finishing hand in 1768. In this performance Linnæus is the methodiser, and the nomenclator of all the known productions of the three kingdoms of nature. His classifications are all so far artificial, that he constitutes divisions and subdivisions from minute qualities in the subject, which serve very well as external marks, but frequently have little relation to its essential character, and therefore bring together things in their nature very dissimilar. They are framed, however, with wonderful ingenuity, and have undoubtedly produced a more accurate indentification in all the branches of natural history than before prevailed. This is the first step to an exact history of any subject, and it is ignorance that treats it with contempt as a mere nomenclature. Although arrangement was the point at which Linnæus peculiarly laboured, yet many of his smaller works prove his great attention to matters of use and curiosity; and no school has contributed so much to a thorough knowledge of the productions of nature as the Linnæan. With regard to the particular parts of his system, the botanical was the most generally received, and bids the fairest for duration. The entomological, though possessing great excellence, has in some measure been abrogated by the more comprehensive but more difficult method of Fabricius. Those in the other branches of zoology are generally in use, but have been improved or rivalled. The mineralogical has been entirely set aside by the great advances made in chemical knowledge. Linnæus also carried his methodising plants into the science of medicine, and published a classified "Materia Medica," and a system of nosology, under the title of "Genera Morborum." Neither of these, however, are considered as happy efforts, and he can scarcely rank among

the improvers of his proper profession, except as having brought into notice some popular remedies, and recorded some curious dietetical observations.

A moderate degree of opulence (considerable indeed relatively to the country in which he lived) attended the honour and reputation which Linnæus enjoyed. He was enabled to purchase an estate and villa at Hammerby, near Upsal, which was his chief summer residence during the last fifteen years of his life. Here he had a museum of natural history, on which he gave lectures; and here he occasionally entertained his friends, but with that œconomy which had become a habit with him, and which the possession of wealth, as is frequently the case, rather straightened than relaxed. His vigour and activity continued to an advanced period, though his memory overburthened with such an immense load of names, began to fail after his sixtieth year. An attack of apoplexy, in May 1774, obliged him to relinquish the most laborious parts of his professional duties, and to close his literary toils. In 1776 a second seizure rendered him paralytic on the right side, and reduced him to a deplorable state of mental and bodily debility. An ulceration of the bladder was the concluding symptom which carried him off, on January 10, 1778, in the seventy-first year of his age. A general mourning took place at Upsal, at his death, and his body was attended to the grave with every token of respect. His memory received distinguished honours, not only in his own country, but from the friends of science in various foreign nations.

Linnæus was below the middle stature, but strong and muscular. His features were agreeable, and his eyes were uncommonly animated. His temper was lively, ardent, irritable; his indignation warm, and his industry indefatigable. He had a large share of natural eloquence, and a good command of language, though his perpetual study of things did not permit him to pay much attention to the ornaments of words. In society he was easy and pleasant; in his domestic relations kind and affectionate; and in the ordinary commmerce of life upright and honourable. His views of nature impressed him with the most devout sentiments towards its author, and a glow of unaffected piety is continually breaking forth throughout his writings. If it be generally true, that men of real merit are modest estimators of themselves, he was an exception to the rule; for vanity was his greatest foible, and no panegyrist could surpass what he has written to his own praise in his diary. He was, however, totally free from envy, and bestowed applause liberally where it was deserved; nor did his love of fame cause him to descend to personal controversies with antagonists. He left a son and four daughters. The former was joint professor of botany with his father, and succeeded to his medical chair: he was well acquainted with botanical science, but had none of his father's genius. The eldest daughter, Elizabeth-Christiana, had a turn for observation, and became known by her discovery of the luminous quality of the flower tropœolum, communicated to the academy at Stockholm.

Of the numerous works of Linnæus, and their different editions, particular catalogues are given in the works from which this article is composed. Stover's Life of Linnnæus. Pulteney's General View of the Writings of Linnæus, second edition, by Dr. Maton, with the Diary of Linnæus, by himself.

LINNET. See Linaria.

LINOCIERA, in botany, so named from Geofroy Linocier, Physician at Tournon, in the Vivarais, a genus of the Diandria Monogynia class and order. Essential character; calyx four-toothed; corolla four-petalled; anthers connecting two opposite petals at the base; berry two-celled.

LINSEED, the seed of the plant linum.

LINSPINS, in the military art, small pins of iron which keep the wheel of a cannon, or waggon, on the axletree; for when the end of the axletree is put through the nave, the linspin is put in, to keep the wheel from falling off.

LINSTOCK, in the military art, a wooden staff, about three feet long, upon one end of which is a piece of iron which divides in two, turning from one another, having each a place to receive a match, and a screw to keep it fast: the other end is pointed, and shod with iron, to stick in the ground. It is used by gunners to fire the guns.

LINT, *linum*, from the flax of which linen is made.

In surgery, the term lint denotes the scrapings of linen which is used in dressing wounds, and is made up in various forms, as tents, dossils, pledgets, &c. See Surgery.

LINUM, in botany, *flax*, a genus of the Pentandria Pentagynia class and order. Natural order of Gruinales. Caryophylleæ, Jussieu. Geranía, Smith. Essential character: calyx five-leaved; petals five; capsule ten-valved, ten-celled; seeds soli-

tary. There are twenty-five species. The several species of flax are mostly herbaceous, some are fruticose, or woody at bottom; two are shrubby, and one arboreous; leaves generally alternate; flowers solitary and axillary; corolla commonly blue, sometimes fading to white, and in some yellow. Flax is found wild in many parts of Europe, in corn fields; in England it is, perhaps, doubtful whether it be aboriginal. It is common in the western counties, not only in corn-fields, but in pastures and on downs.

LION. See FELIS.

LIONCELLES, in heraldry, a term used for several lions borne in the same coat of arms.

LIP, *hare*, a disorder in which the upper lip is in a manner slit or divided, so as to resemble the upper lip of a hare, whence the name.

LIPARIA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx five-cleft, with the lowest segment elongated; corolla wings two-lobed below; stamina the larger, with three shorter teeth; legume ovate. There are five species, natives of the Cape of Good Hope.

LIPPIA, in botany, so named from Augustine Lippi, a genus of the Didynamia Gymnospermia class and order. Natural order of Stellatæ. Vitices, Jussieu. Essential character: calyx four-toothed, roundish, upright, compressed, membranaceous; capsule one-celled, two-valved, two-seeded, straight; seed one, two-celled. There are five species.

LIQUID. Fluids have been divided into two classes; *viz.* those which are elastic, and the non-elastic, or those which do not sensibly diminish in bulk when subjected to pressure. The first class are airs or gases, the second liquids: hence we may define a liquid to be a fluid not sensibly elastic, the parts of which yield to the smallest impression, and move on each other. When liquid bodies are mixed together, they act in various ways, according to the nature of the substances employed. Some dissolve each other in any proportion, as in the case with most gases when mixed; some unite in determinate proportion; some do not act sensibly upon each other, separating again, though mixed ever so carefully; and some decompose each other.

LIQUIDAMBER, in botany, a genus of the Monoecia Polyandria class and order. Natural order of Coniferæ. Amentaceæ, Jussieu. Essential character: male, calyx common, four-leaved; corolla none: filaments numerous: female: calyx in a globe, four-leaved; corolla none; styles two: capsules many in a globe, two-valved, many-seeded. There are two species, *viz.* L. styraciflua, maple-leaved liquidamber, or sweet gum; and L. imberbe, oriental liquidamber; the trunk of the former is usually two feet in diameter, straight, and free from branches, to the height of fifteen feet; whence the branches spread and rise in a conic form forty feet from the ground. The leaves are shaped like those of the lesser maple, of a dark green colour, their upper surfaces shining; a sweet glutinous substance exudes through their pores in warm weather, which renders them clammy to the touch; in February, before the leaves are formed, the blossoms break forth from the tops of the branches into spikes of yellowish red pappose globular flowers, which swell gradually, retaining their round form to the full maturity of their seed vessels, which are thick set with pointed hollow protuberances, and splitting open discharge their seeds. The wood of this tree is good timber, and is used in wainscotting, &c.; the grain is fine, some of it is beautifully variegated. When wrought too green it is apt to shrink. From between the wood and the bark issues a fragrant gum, which trickles from the wounded trees, and by the heat of the sun congeals into transparent drops, which the Indians chew as a preservative to their teeth; it smells very much like Balsam of Tolu, so that it is difficult to distinguish them. The bark is of singular use to the Indians for covering their huts. Native of North America.

LIQUOR *of flints*. Alkalies have a powerful action on silica: they combine in different proportions; two or three parts of potash, with one of silica, give a compound, which is deliquescent in the air, and soluble in water: this was formerly distinguished by the name of liquor of flints, but it is now denominated silicated alkali.

LIQUORICE. The glycirrhiza, or common liquorice shrub, has a long, thick, creeping root, striking several feet deep into the ground; an upright, firm, herbaceous, annual stalk, three or four feet high, garnished with winged leaves, of four or five pair of oval lobes, terminated by an odd one: and from the axillas, erect spikes of pale blue flowers in July, succeeded by short smooth pods. The root of this plant is the useful part, being replete with a sweet, balsamic, pectoral juice, which is either extracted, or the wood sold in substance. It is much used

n all compositions for coughs, and disorders of the stomach; but by far the greatest quantity is used by brewers. The common liquorice is cultivated in most countries of Europe, for the sake of its root; but in Spain and Italy, and particularly in Sicily and Calabria, it makes a considerable article of commerce with this country. In Calabria, liquorice is chiefly manufactured, and exported from Corigliano, Rossano, Cassano, and Palermo. The Calabrian liquorice, upon the whole, is preferable to that coming from Sicily, and the Italian paste to that coming from Spain. Liquorice also grows in great abundance in the Levant; and vast quantities of it are consumed there, in making a decoction, which is drank cold in the summer, in the manner of sherbet.

To prepare liquorice, the roots are boiled a long time in water, till the fluid has got a deep yellow tincture; and the water at length evaporated till the remains acquire a consistency, when they are formed into sticks, which are packed up with bay leaves, in the same order as we receive them. The boiling requires the utmost care and precaution, as the juice takes an unpleasant smell and flavour, if burnt in the least degree.

LIRIODENDRUM, in botany, a genus of the Polyandria Polygynia class and order. Natural order of Coadunatæ. Magnoliæ, Jussieu. Essential character: calyx three-leaved; petals six; seeds imbricated into a strobile. There are two species, *viz.* L. tulipifera, common tulip tree; and L. lillifera; the former is a native of North America, where it is a tree of the first magnitude, and is generally known in all the English settlements by the name of poplar. The young shoots of this tree are covered with a smooth purplish bark; they are garnished with large leaves, whose foot-stalks are four inches long; the leaves are of a singular form, being divided into three lobes; the middle lobe is blunt and hollowed at the point, appearing as if it had been cut with scissars; the upper surface of the leaves is smooth, and of a lucid green, the under of a pale green; the flowers are produced at the end of the branches, composed of six petals, three without and three within, forming a sort of bell-shaped flower, whence the inhabitants of North America gave it the name of tulip; the petals are marked with green, yellow, and red spots, making a beautiful appearance when the trees are charged with flowers; when the flowers fall off, the germ swells, and forms a kind of cone, which does not ripen in England; the handsomest tree of this kind, near London, is in a garden at Waltham Abbey.

The wood is used for canoes, bowls, dishes, spoons, and all sorts of joiners' work.

Kalm speaks of having seen a barn of considerable size, the sides and roof of which were made of a single tulip-tree split into boards; there is no wood that contracts and expands so much as this, which is a great inconvenience attending it; the bark is divisible into thin laminæ, which are tough like bast.

LISIANTHUS, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Rotaceæ. Gentianæ, Jussieu. Essential character: calyx keeled; corolla with a ventricose tube, and recurved divisions; stigma two-plated; capsule two-celled, two-valved; the margins of the valves intorted. There are nine species, natives of Jamaica.

LISTING. Persons listed are to be carried within four days, but not sooner than twenty-four hours, after they have enlisted, before the next justice of peace of any county, riding, city, or place, or chief magistrate of any city or town corporate (not being an officer in the army); and if, before such justice or magistrate they dissent from such listing, and return the listing money, and also twenty shillings, in lieu of all charges expended on them, they are to be discharged. But such persons refusing or neglecting to return and pay such money within twenty-four hours, shall be deemed as duly listed as if they had assented thereto before the proper magistrate; and they will, in that case, be obliged to take the oath, or upon refusal they shall be confined by the officer who listed them till they do take it. Persons owning before the proper magistrate, that they voluntarily listed themselves, are obliged to take the oath, or suffer confinement by the officer who listed them till they do take it. The magistrate is obliged, in both cases, to certify that such persons are duly listed; setting forth their birth, age, and calling, if known; and that the second and sixth sections of the articles of war, against mutiny and desertion, were read to them, and that they had taken the oath. Officers offending herein are to be cashiered, and displaced from their office; to be disabled from holding any post, civil or military; and to forfeit 100*l.* Persons receiving inlisting money from any officer,

knowing him to be such, and afterwards absconding, and refusing to go before a magistrate to declare their assent or dissent, are deemed to be inlisted to all intents and purposes, and may be proceeded against as if they had taken the oath.

LITA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Rotaceæ. Gentianæ, Jussieu. Essential character: calyx five-cleft, with two or three scales at the base; corolla salver-shaped, with a long tube, dilated at the base and throat; border five-cleft; anthers twin, inserted in the throat; capsule one-celled, two-valved; seeds numerous. There are two species, *viz.* L. rosea, and L. cærulea; natives of Guiana.

LITANY, a solemn form of supplication to God, in which the priest utters some things fit to be prayed for, and the people join in their intercession, saying, "We beseech Thee to hear us, good Lord," &c.

At first, the use of litanies was not fixed to any stated time, but were only employed as exigencies required. They were observed, in imitation of the Ninevites, with ardent supplications and fastings, to avert the threatening judgments of fire, earthquakes, inundations, or hostile invasions. About the year 400, litanies began to be used in processions, the people walking barefoot, and repeating them with great devotion; and it is pretended, that by this means, several countries were delivered from great calamities. The days on which these were used, were called rogation days: these were appointed by the canons of different councils, till it was decreed by the council of Toledo, that they should be used every month throughout the year; and thus by degrees they came to be used weekly on Wednesdays and Fridays, the ancient stationary days for fasting. To these days the rubric of our church has added Sundays, as being the greatest days for assembling at divine service. Before the last review of the "Common Prayer," the litany was a distinct service by itself, and used some time after the morning prayer was over; at present it is made one office with the morning service, being ordered to be read after the third collect for grace, instead of the intercessional prayers in the daily service.

LITERARY *property*. Authors, it should seem, had, by the common law, the sole and exclusive copy-right remaining in themselves or their assigns in perpetuity, after having printed and published their compositions. This, as a common law right, was strangely questioned by some of our judges, who studied special pleading more than common sense. But by statute 8 Anne, c. 19, it is secured to them for fourteen years, from the day of publishing; and after the end of fourteen years, the sole right of printing or disposing of copies, shall return to the authors, if then living, for other fourteen years. This statute, it has been held, restrains the right of the author and his assigns to the fourteen or the twenty-eight years, whatever it might have been at the common law. A penalty on each sheet found in the possession of a party pirating a work, is inflicted by the statute, 9 Anne, c. 19; and, in order to entitle the plaintiff to recover this penalty, the book must have been entered at Stationers' Hall. But an author whose work has been pirated, may maintain an action for damages merely, without having so entered his book. When an author transfers all his right or interest in a publication to another, and happens to survive the first fourteen years, the second term will result to his assignee, and not to himself. By statute 12 Geo. II. c. 36. 34 Geo. III. c. 20, s. 57, books printed in England originally, may not be reprinted abroad, and imported within twenty years. A last act extends also to Ireland, where English books were frequently pirated. By statute 8 Geo. II. c. 13; 7 Geo. III. c. 28; 17 Geo. III. c. 57. Engravers have a property in their prints and engravings for twenty-eight years absolutely. A fair abridgment is equally protected with an original work. Acting a play on a stage is not a publishing within the statute, 8 Anne, c. 19; but one cannot take a piece in short hand and print it before the author has published it.

LITERATE, in natural history, ornamented with characters like letters.

LITHARGE, in the arts. Lead is easily oxydable. When first fused its surface is perfectly bright, but by the contact of the air it is quickly covered with a thick film, called the dross of lead. If this be taken off, the same circumstences again take place, and thus the whole of the lead may be converted into a kind of grey powder, which is the oxide of lead. By exposing it to a higher degree of heat, it acquires a yellow colour, forming a pigment named "massicot:" and by a still greater heat, and causing the flame to play upon the surface, while the powder is constantly stirred, the yellow colour becomes red, and the substance is then called minium, or red lead, which is a metal in a

high degree of oxydizement. By a particular management of the heat, during the oxydizement of lead, supplying it quickly with a current of air blown over the surface of the metal, the oxide is semi-vitrified, forming the soft flaky substance named litharge. By a stronger heat, the lead may be vitrified, when it forms the glass of lead.

LITHOMARGE, in mineralogy, is a species of the clay genus, and divided by Werner and others into two sub-species, *viz.* the friable and the indurated. Friable lithomarge, or rock-marrow, is white and massive; it occurs likewise as a crust, and disseminated. Its lustre is feebly glimmering, is generally coherent, feels greasy, and adheres to the tongue. It is found in large quantities in the Saxon tin veins. Indurated lithomarge is commonly white, but with many varieties of colour. The white and red are uniform, but the other colours are usually disposed in clouded and spotted delineations. It is found in many parts of Germany, and occurs in veins of porphyry, gneiss and serpentine; in drusy cavities of topaz rock, or nidular in basalt, amygdaloid and serpentine; and in beds over coal. According to Jameson, the terra-miraculosa, which is remarkable for the beauty of its coloured delineations, is a variety of the indurated lithomarge.

LITHOPHILA, in botany, a genus of the Diandria Monogynia class and order. Essential character: calyx three-leaved; corolla three-petalled; nectary two-leaved. There is only one species, a native of Navaza.

LITHOSPERMUM, in botany, *gromwell*, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Essential character: calyx five-parted; corolla funnel form, perforated at the throat. There are twelve species, natives of most parts of Europe, particularly in corn-fields and waste places, flowering from May to July.

LITHOTOMY, in surgery, the operation by which a calculus is removed from the bladder.

LITMUS, in chemistry, a substance, the tincture of which is extremely useful, as a test of the presence of an acid or alkali. All acids, and salts, with an excess of acid, change the natural violet purple of litmus to red; when reddened by an acid, the blue is restored by an alkali.

LITTORELIA, in botany, *plaintain shoreweed*, a genus of the Monoecia Tetrandria class and order. Natural order of Plantagines, Jussieu. Essential character: male, calyx four-leaved; corolla four-cleft; stamina long: female, calyx none; corolla slightly, four-cleft; styles long; seed, a nut.

LITURGY, a name given to those set forms of prayer which have been generally used in the Christian church. Of these there are not a few ascribed to the apostles and fathers, but they are almost universally allowed to be spurious.

LIVER, in anatomy, a very large viscus, of a red colour, situated in the right hypochondrium, and serving for the secretion of the bile or gall. See ANATOMY; PHYSIOLOGY.

LIVER, a name formerly given to different chemical combinations, because they were supposed to resemble the animal liver in colour only. Thus we had liver of sulphur, liver of antimony, &c. &c. See SULPHURET.

LIVERY *of seisin*, a delivery of possession of lands, tenements, or other corporeal thing (for of things incorporeal there can be no seisin) to one that has right.

Livery of seisin must be on the land, in the presence of two witnesses, and was anciently used to give publicity to gifts or transfers of land. It is now necessary, in order to complete a feoffment, and to make good a lease for life or grant of the freehold to commence at a future day. See ESTATE, LEASE. Where there is land and a house, it must be made in the house, that being the principal.

LIVERYMEN, of London, are a number of men chosen from among the freemen of each company. Out of this body the common council, sheriff, and other superior officers for the government of the city, are elected, and they alone have the privilege of giving their votes for members of parliament; from which the rest of the citizens are excluded.

LIZARD. See LACERTA

LOAM, in mineralogy, is a sub-species of the clay genus, and of a yellowish gray colour, frequently spotted yellow and brown. It occurs massive, is dull, and sometimes weakly glimmering. It adheres pretty strongly to the tongue, feels greasy, and is not very heavy: it is generally mixed with sand and gravel, and also iron ochre. According to Mr. Jameson, it may be considered as sandy potter's clay, mixed with mica and iron ochre. See CLAY.

LOAN, in finance, money borrowed by government for defraying the extraordinary expenses of the state.

The comparative advantage or disadvantage of the terms, on which the public loans have been obtained at different periods, has frequently been misrepresented, either from misconception or for party purposes, though it is evidently a subject on which the truth is very easily ascertained. The economy or extravagance of every transaction of this kind depends on its correspondence or disagreement with the price of the public funds, and the current rate of interest at which money could be obtained on good security at the time the bargain was concluded; and, consequently, a loan, on which the highest interest is paid, may have been obtained on the best terms that could be made at the time it was negotiated. The interest paid, however, forms the real burden of each loan to the country; for, since the mode of buying up stock at the market price has been adopted in the redemption of the debt, the nominal capital that is created has become but of little importance, though certainly not to be wholly disregarded.

The first loans differed materially from those of subsequent periods, in being raised wholly on terminable annuities; and in having a particular fund assigned for each loan, by the supposed adequateness or insufficiency of which the interest required by the lenders was frequently influenced, as well as by other causes, which have since ceased to exist.

During the reign of Queen Anne, loans were chiefly raised on annuities for 99 years, till 1711; when, by the establishment of the South Sea Company, a variety of debts were consolidated and made a permanent capital, bearing 6 per cent. interest. About this period lotteries were also frequently adopted for raising money for the public service, under which form a considerable premium was given, in addition to a high rate of interest. This mode of raising money was followed in 1712, 1713, and 1714. In the latter year, though the interest paid was equal to only *5l. 7s. 2d.* per cent. on the sum borrowed, the premium allowed was upwards of *34l* per cent.; but, as peace was restored, and the legal rate of interest had been reduced to 5 per cent. it seems that a larger premium was allowed, for the sake of appearing to borrow at a moderate rate of interest.

In the reign of George I. the interest on a considerable part of the public debts was reduced to 5 per cent. and the few loans that were raised were, comparatively, of small amount; that of the year 1720, was obtained at little more than 4 per cent. interest.

About 1730 the current rate of interest was 3½ per cent.; and, in 1736, government was enabled to borrow at 3 per cent. per annum. The extraordinary sums necessary for defraying the expenses of the war, which began in 1739, were at first obtained from the sinking fund and the salt-duties; a payment from the Bank, in 1742, rendered only a small loan necessary in that year, which was obtained at little more than 3 per cent. interest. In the succeeding years the following sums were raised by loans.

	Sum borrowed.	Interest.		
	L.	*L.*	*s.*	*d.*
1743	1,800,000	3	8	4
1744	1,800,000	3	6	10
1745	2,000,000	4	0	7
1746	2,500,000	5	5	1
1747	4,000,000	4	8	0
1748	6,300,000	4	8	0
Loans of the seven years' war.				
1756	2,000,000	3	12	0
1757	3,000,000	3	14	3
1758	5,000,000	3	6	5
1759	6,600,000	3	10	9
1760	8,000,000	3	13	7
1761	12,000,000	4	1	11
1762	12,000,000	4	10	9
1763	3,000,000	4	4	2
Loans of the American war.				
1776	2,000,000	3	9	8
1777	5,000,000	4	5	2
1778	6,000,000	4	18	7
1779	7,000,000	5	18	10
1780	12,000,000	5	16	8
1781	12,000,000	5	11	1
1782	13,500,000	5	18	1
1783	12,000,000	4	13	9
1784	6,000,000	5	6	11
Loans of the war with the French Republic.				
1793	4,500,000	4	3	4
1794	11,000,000	4	10	9
1795	18,000,000	4	15	8
1796	18,000,000	4	14	9
1796	7,500,000	4	12	2
1797	18,000,000	5	14	1
1797	14,500,000	6	6	10
1798	17,000,000	6	4	9
1799	3,000,000	5	12	5
1799	15,500,000	5	5	0
1800	20,500,000	4	14	2
1801	28,000,000	5	5	5

The sums borrowed since the commencement of the war, which began in 1803, have hitherto been of somewhat less extent, as it has been deemed necessary to endeavour to raise a considerable part of the extraordinary sums wanted within the year.

LOASA, in botany, a genus of the Polyandria Monogynia class and order. Essential character: calyx five-leaved, superior; corolla five-petalled; petals hooded; nectary five-leaved, converging; capsule turbinate, one celled, three valved, many seeded. There is only one species, *viz.* L. hispida, a native of South America.

LOBARIA, in natural history, a genus of the Vermes Mollusca class and order. Body above convex, beneath flat lobate. There is but a single species, *viz.* L. quadriloba, which inhabits the northern seas. It has a tail with four lobes.

LOBE, in anatomy, any fleshy protuberant part, as the lobes of the lungs, lobes of the ears, &c.

LOBELLA, in botany, so named from Matthias de Lobel, a Flemish botanist, a genus of the Syngenesia Monogamia class and order. Natural order of Campanaceæ. Campanulaceæ, Jussieu. Essential character: calyx five-cleft; corolla one petalled, irregular; capsule inferior, two or three-celled. There are forty-two species; these are mostly herbaceous plants, some annual, more perennial, and a few suffruticose, or woody at the bottom of the stems, which in some are prostrate, in others upright; leaves alternate; flowers either solitary and axillary with two small bractes, or in loose terminating spikes with three little bractes. The predominant colour of the corollas is blue; they are chiefly natives of the Cape of Good Hope.

LOCAL *action*, is an action restrained to the proper county, in opposition to a transitory action, which may be laid in any county, at the plaintiff's discretion. In local actions, where possession of land is to be recovered, or damages for an actual trespass, or for waste, or the like, affecting land, the plaintiff must lay his declaration, or declare his injury to have happened in the very county and place that it really did happen in; but in transitory actions, for injuries that may happen any where, as debt, detinue, slander, and the like, the plaintiff may declare in what county he pleases, and then the trial must be in that county in which the declaration is laid; though if the defendant will make affidavit that the cause of action, if any, arose not in that, but in another county, the court will oblige the plaintiff to declare in the proper county.

LOCAL *problem*, among mathematicians, such a one as is capable of an infinite number of different solutions, by reason that the point which is to resolve the problem may be indifferently taken within a certain extent, as, suppose any where, within such a line, within such a plane, figure, &c. which is called a geometric locus, and the problem is said to be a local or indetermined one. See Locus.

A local problem may be either simple, when the point sought is in a right line; plane, when the point sought is in the circumference of a circle; solid, when the point required is in the circumference of a conic section; or, lastly, sursolid, when the point is in the perimeter of a line of the second gender, or of an higher kind, as geometers call it.

LOCK, an instrument used for fastening doors, chests, &c. generally opened by a key. The lock is esteemed the master-piece in smithery; much art and delicacy being required in contriving and varying the wards, bolts, and springs. From the different structure of locks, accommodated to their different use, they acquire different names; thus, those placed on outer doors are called stock-locks; those on inner doors, spring-locks; those on trunks, trunk-locks, padlocks, &c. Of these the spring-lock is the most curious: its principal parts are, the main-plate, the cover-plate, and the pin hole: to the main-plate belong the key-hole, top-hook, cross-wards, bolt-toe, or bolt-nab, drawback-spring, tumbler, pin of the tumbler, and the staples; to the cover-plate belong the pin, main-ward, cross-ward, step-ward, or dapper-ward; to the pin-hole belong the hook-ward, main cross-ward, shank, the pot or bread, bit, and bow-ward. The importation of locks is prohibited.

Lock, or Weir, in inland navigations, the general name for all those works of wood or stone, made to confine and raise the water of a river; the banks, also, which are made to divert the course of a river, are called by these names in some places. But the term lock is more particularly appropriated to express a kind of canal inclosed between two gates; the upper called by workmen the sluice-gate, and the lower called the flood-gate. These serve in artificial navigations to confine the water, and render the passage of boats easy in passing up and down the stream. See Canal.

LOCUS *geometricus*, denotes a line, by

which a local or indeterminate problem is solved. See LOCAL PROBLEM.

A locus is a line, any point of which may equally solve an indeterminate problem. Thus, if a right line suffice for the construction of the equation, it is called *locus ad rectum;* if a circle, *locus ad circulum;* if a parabola, *locus ad parabolam;* if an ellipsis, *locus ad ellipsin;* and so of the rest of the conic sections.

The loci of such equations as are right lines, or circles, the ancients called *plain loci;* and of those that are parabolas, hyperbolas, &c. *solid loci.* But Wolfius, and others, among the moderns, divide the loci more commodiously into orders, according to the numbers of dimensions to which the indeterminate quantities rise. Thus, it will be a locus of the first order, if the equation is $x = \frac{ay}{c}$; a locus of the second or quadratic order, if $y^2 = a\,x$, or $y^2 = a^2 - x^2$; a locus of the third or cubic order, if $y^3 = a^2\,x$, or $y^3 = a\,x^2 - x^3$, &c.

The better to conceive the nature of the locus, suppose two unknown and variable right lines A P, P M (Plate VIII. Miscel. fig. 4 and 5) making any given angle A P M with each other; the one whereof, as A P, we call x, having a fixed origin in the point A, and extending itself indefinitely along a right line given in position; the other P M, which we call y, continually changing its position, but always parallel to itself. An equation only containing these two unknown quantities, x and y, mixed with known ones, which expresses the relation of every variable quantity A P, (x), to its correspondent variable quantity P M, (y): the line passing through the extremities of all the values of y, *i. e.* through all the points M, is called a *geometrical locus,* in general, and the locus of that equation in particular.

All equations, whose loci are of the first order, may be reduced to some one of the four following formulas: 1. $y = \frac{b\,x}{a}$. 2. $y = \frac{b\,x}{a} + c$. 3. $y = \frac{b\,x}{a} - c$. 4. $y = c - \frac{b\,x}{a}$. Where the unknown quantity, y, is supposed always to be freed from fractions, and the fraction that multiplies the other unknown quantity, x, to be reduced to this expression $\frac{b}{a}$, and all the known terms to c.

The locus of the first formula being already determined: to find that of the second, $y = \frac{b\,x}{a} + c$; in the line A P, fig. 6, take A B $= a$, and draw B E $= b$, A D $= c$, and parallel to P M. On the same side A P, draw the line A E of an indefinite length towards E, and the indefinite straight line D M parallel to A E. Then the line D M is the locus of the aforesaid equation, or formula; for if the line M P be drawn from any point M thereof parallel to A Q, the triangles A B E, and A P F, will be similar: and therefore A B (a) : B E (b) :: A P (x) P F $= \frac{b\,x}{a}$; and consequently P M (y) = P F $\left(= \frac{b\,x}{a}\right) +$ F M (c).

To find the locus of the third form, $y = \frac{b\,x}{a} - c$, proceed thus: assume A B $= a$ (fig. 7); and draw the right lines B E $= b$, A D $= c$ and parallel to P M, the one on one side A P, and the other on the other side: and through the points A E, draw the line A E of an indefinite length towards E, and through the point D, the line D M parallel to A E: then the indefinite right line G M shall be the locus sought; for we shall have always P M $= (y) =$ P F $= \left(\frac{b\,x}{a}\right) -$ F M (c).

Lastly, to find the locus of the fourth formula, $y = c - \frac{b\,x}{a}$; in A P (fig. 8): take A B $= a$, and draw B E $= b$, A D $= c$, and parallel to P M, the one on one side A P, and the other on the other side; and through the points A and E, draw the line A E indefinitely towards E, and through the point D draw the line D M parallel to A E. Then D G shall be the locus sought; for if the line M P be drawn from any point M thereof parallel to A Q, then we shall always have P M $=$ F M $-$ P F, that is, $y = c - \frac{b\,x}{a}$.

Hence it appears, that all the loci of the first degree are straight lines; which may be easily found, because all their equations may be reduced to some one of the foregoing formulas.

All loci of the second degree are conic sections, *viz.* either the parabola, the circle, ellipsis, or hyperbola: if an equation therefore be given, whose locus is of the second degree, and it be required to draw the conic section, which is the locus thereof; first draw a parabola, ellipsis, or hyperbola; so as that the equations expressing the natures thereof may be as

compound as possible. In order to get general equations, or formulas, by examining the peculiar properties whereof we may know which of these formulas the given equation ought to have regard to; that is, which of the conic sections will be the locus of the proposed equation. This known, compare all the terms of the proposed equation with the terms of the general formula of that conic section, which you have found will be the locus of the given equation; by which means you will find how to draw the section, which is the locus of the equation given.

For example; let A P $= x$, P M $= y$, be unknown, and variable straight lines (fig. 9); and let m, n, p, r, s, be given right lines: in the line A P take A B $= m$, and draw B E $= n$, A D $= r$ and parallel to P M; and through the point A draw A E $= e$, and through the point D the indefinite right line D G parallel to A E. In D G take D C $= s$, and with C G, as a diameter, having its ordinates parallel to P M, and the line C H $= p$, as the parameter, describe a parabola C M: then the portion thereof, included in the angle P A D, will be the locus of the following general formula:

$$yy - \frac{2nxy}{m} + \frac{nnxx}{mm} - 2ry + \frac{2nrx}{m} + rr - \frac{epx}{m} + ps. = o.$$

For if from any point M of that portion there be drawn the right line M P, making any angle A P M with M P; the triangles A B E, A P F, shall be similar; therefore,

A B : A E :: A P : A F or D G; that is, $m : e :: x : \frac{ex}{m}$. And A B : B E :: A P : P F; that is, $m : n :: x : \frac{nx}{m}$. And consequently, G M or P M — P F — F G $= y - \frac{nx}{m} - r$. And C G or D G — D C $= \frac{ex}{m} - s$. But from the nature of the parabola G M² $=$ C G $\times$ C H; which equation will become that of the general formula, by putting the literal values of those lines.

Again, if through the fixed point A you draw the indefinite right line A Q (fig. 10), parallel to P M, and you take A B $= m$, and draw B E $= n$ parallel to A P, and through the determinate points A E, the line A E $= e$; and if in A P you take A D $= r$: and draw the indefinite straight line D G parallel to A E, and take D C $= s$: this being done, if with the diameter C G, whose ordinates are parallel to A P, and parameter the line C H $= p$, you describe a parabola C M; the portion of this parabola contained in the angle B A P shall be the locus of this second equation, or formula:

$$xx - \frac{2nyx}{m} + \frac{nnyy}{mm} - 2rx + \frac{2nry}{m} + rr - \frac{epy}{m} + ps. = o.$$

For, if the line M Q be drawn from any point M, therein, parallel to A P; then will A B : A E :: A Q or P M : A F or D G; that is, $m : e :: y : \frac{ey}{m}$; and A B : B E :: A Q : Q F; that is, $m : n :: y : \frac{ny}{m}$. And therefore G M or Q M — Q F — F G $= x - \frac{ny}{m} - r$; and C G or D G — D C $= \frac{ey}{m} - s$.

And so by the common property of the parabola, you will have the foregoing second equation, or formula. So likewise may be found general equations for the other conic sections.

Now if it be required to draw the parabola, which we find to be the locus of this proposed equation $yy - 2ay - bx + ec = o$; compare every term of the first formula with the terms of the equation, because yy in both is without fractions; and then will $\frac{2n}{m} = o$, because the rectangle xy not being in the proposed equation, the said rectangle may be esteemed as multiplied by o; whence $n = o$, and $m = e$; because the line A E falling in A B, that is, in A P in the construction of the formula, the points B E do coincide. Therefore destroying all the terms adfected with $\frac{n}{m}$ in the formula, and substituting m for e, we shall get $yy - 2ry - px + rr + ps = o$. Again, by comparing the correspondent terms $-2ry$ and $-2ay$, as also $-px$ and $-bx$, we have $r = a$, and $p = b$; and comparing the terms wherein are neither of the unknown quantities xy, we get $rr + ps = cc$; and substituting a and b for r and p, then will $s = \frac{cc - aa}{b}$, which is a negative expression when a is greater than c, as is here supposed. There is no need of comparing the first terms yy and yy, because they are the same. Now the values of n, r, p, s, be-

ing thus found, the sought locus may be constructed by means of the construction of the formula, and after the following manner.

Because $BE = n = o$ (fig. 9), the points B E do coincide, and the line A E falls in A P; therefore through the fixed point A draw the line $AD = r = a$ parallel to P M, and draw D G parallel to A P, in which take $DC = \frac{aa - cc}{b} = -s$; then with D C, as a diameter, whose ordinates are right lines parallel to P M, and parameter the line $CH = p = b$, describe a parabola: then the two portions O M M, R M S, contained in the angle P A O, formed by the line A P, and the line A O drawn parallel to P M, will be the locus of the given equation, as is easily proved.

If in a given equation whose locus is a parabola, xx is without a fraction; then the term of the second formula must be compared with those of the given equation.

Thus much for the method of constructing the loci of the equations which are conic sections. If, now, an equation, whose locus is a conic section, be given, and the particular section whereof it is the locus be required, all the terms of the given equation being brought over to one side, so that the other be equal to nothing, there will be two cases.

Case I. When the rectangle xy is not in the given equation. 1. If either yy or xx be in the same equation, the locus will be a parabola. 2. If both xx and yy are in the equation with the same signs, the locus will be an ellipsis, or a circle. 3. If xx and yy have different signs, the locus will be an hyperbola, or the opposite sections regarding their diameters.

Case II. When the rectangle xy is in the given equation. 1. If neither of the squares xx or yy, or only one of them, be in the same, the locus of it will be an hyperbola between the asymptotes. 2. If yy and xx be therein, having different signs, the locus will be an hyperbola regarding its diameters. 3. If both the squares xx and yy are in the equation, having the same signs, you must free the square yy from fractions; and then the locus will be an hyperbola, when the square of $\frac{1}{2}$ the fraction multiplying xy, is equal to the fraction multiplying xx; an ellipsis, or circle, when the same is less; and an hyperbola, or the opposite sections, regarding their diameters, when greater.

LOCUST. See GRYLLUS.

LODGMENT, in military affairs, is a work raised with earth, gabions, fascines, wool-packs, or mantelets, to cover the besiegers from the enemy's fire, and to prevent their losing a place which they have gained, and are resolved, if possible, to keep. For this purpose, when a lodgment is to be made on the glacis, covert-way, or in a breach, there must be great provision made of fascines, sand-bags, &c. in the trenches; and during the action, the pioneers with fascines, sand-bags, &c. should be making the lodgment, in order to form a covering in as advantageous a manner as possible from the opposite bastion, or the place most to be feared.

LOEFLINGIA, in botany, so called from Peter Loefling; a genus of the Triandria Monogynia class and order. Natural order of Caryophyllei. Essential character: calyx five-leaved; corolla five-petalled, very small; capsule one-celled, three valved. There is but one species, *viz.* L. hispanica, a native of Spain.

LOESELIA, in botany, from Joseph Loesel, a genus of the Didynamia Angiospermia class and order. Natural order of Convolvuli, Jussieu. Essential character; calyx four-cleft; corolla with all the segments directed one way; stamina opposite to the petal; capsule three-celled. There is but one species, *viz.* L. ciliata, found at La Vera Cruz in South America.

LOG, in naval affairs, a machine used to measure the rate of a ship's velocity through the water. For this purpose, there are several various inventions, but the one most generally used is the following, called the common log. It is a piece of thin board, forming the quadrant of a circle of about six inches radius, and balanced by a small plate of lead nailed on the circular part, so as to swim perpendicular in the water, with the greater part immersed. The log-line is fastened to the log, by means of two legs, one of which is knotted through a hole at one corner, while the other is attached to a pin fixed in a hole at the other corner, so as to draw out occasionally. The log-line being divided into certain spaces (which are in proportion to an equal number of geographical miles, as a half, or quarter minute, is to an hour of time), is wound about a reel. The whole is employed to measure the ship's headway in the following manner: the reel being held by one man, and the half minute-glass by another, the mate of the

watch fixes the pin, and throws the log over the stern, which, swimming perpendicularly, feels an immediate resistance, and is considered as fixed, the line being slackened over the stern to prevent the pin coming out. The knots are measured from a mark on the line, at the distance of twelve or fifteen fathoms from the log; the glass is therefore turned at the instant that the mark passes over the stern; and as soon as the sand in the glass has run out, the line is stopped; the water then being on the log dislodges the pin, so that the board now presenting only its edge to the water is easily drawn aboard. The number of knots and fathoms which had run off at the expiration of the glass determines the ship's velocity. The half minute glass and divisions on the line should be frequently measured, to determine any variation in either of them, and to make allowance accordingly. If the glass runs thirty seconds, the distance between the knots should be fifty feet. When it runs more or less, it should, therefore, be corrected by the following analogy. As thirty is to fifty, so is the number of seconds of the glass to the distance between the knots upon the line. As the heat or moisture of the weather has often a considerable effect on the glass, so as to make it run slower or faster, it should be frequently tried by the vibrations of a pendulum. As many accidents attend a ship during a day's sailing, such as the variableness of wind, the different quantity of sail carried, &c. it will be necessary to heave the log at every alteration; but if none of these alterations be perceptible, yet it ought to be constantly heaved. In ships of war and East Indiamen, it is usual to heave the log once every hour, and in all other vessels once in two hours; and if at any time of the watch the wind has increased or abated in the intervals, so as to affect the ship's velocity, the officer generally makes a suitable allowance for it at the close of the watch.

Log *board*, a table generally divided into five columns, in the first of which is entered the hour of the day; in the second, the course steered; in the third, the number of knots run off the reel each time of heaving the log; in the fourth, from what point the wind blows; and in the fifth, observations on the weather, variation of the compass, &c.

Log *book*, a book ruled in columns like the log-board, into which the account on the log-board is transcribed every day at noon; from whence, after it is corrected, &c. it is entered into the journal.

Log *wood*, in the arts, is derived from a low prickly tree, which is found in great plenty at Campeachy, in the bay of Honduras, and is denominated "hæmatoxylon campechianum." It comes to Europe in large logs, cleared from the bark, and is very hard, compact, heavy, and of a red colour. It is in high request among dyers, especially in dyeing black. It gives out the colour both to water and alcohol; the liquor at first assumes a fine red colour with a shade of purple. The infusion becomes gradually deeper, and at last almost black. To cloth previously boiled in alum and tartar, it gives a beautiful violet colour, which, however, will not stand. Alkalies render the colour darker, acids change it to yellow. From a variety of experiments it is found, that the colouring matter of log-wood bears in many respects a strong analogy to tannin, but in others it differs from it.

LOGARITHMIC, in general, something belonging to logarithms. See Logarithms.

Logarithmic *curve*. If on the line A N (Plate VIII. Miscel. fig. 12) both ways indefinitely extended, be taken A C, C E, E G, G I, I L, on the right hand. And also A *g*, *g* P, &c. on the left, all equal to one another. And, if at the points P, *g*. A, C, E, G, I, L, be erected to the right line, A N, the perpendiculars P S, *g d*, A B, C D, E F, G H, I K, L M, which let be continually proportional, and represent numbers, *viz.* A B, 1, C D, 10, E F, 100, &c. then shall we have two progressions of lines, arithmetical and geometrical: for the lines A C, A E, A G, &c. are in arithmetical progression, or as 1, 2, 3, 4, 5, &c. and so represent the logarithms to which the geometrical lines A B, C D, E F, &c. do correspond. For since A G is triple of the right line A C, the number G H shall be in the third place from unity, if C D be in the first: so, likewise, shall L M be in the fifth place, since A L = 5 A C. If the extremities of the proportionals S *d*, B, D, F, &c. be joined by right lines, the figure S B M L will become a polygon, consisting of more or less sides, according as there is more or less terms in the progression.

If the parts A C, C E, E G, &c. be bisected in the points *c*, *e*, *g*, *i*, *l*, and there be again raised the perpendiculars *c d*, *e f*, *g h*, *i k*, *l m*, which are mean proportionals between A B, C D; C D, E F, &c. then there will arise a new series of propor-

tionals, whose terms beginning from that which immediately follows unity, are double of those in the first series, and the difference of the terms are become less, and approach nearer to a ratio of equality than before. Likewise, in this new series, the right lines A L, A *c*, express the distances of the terms L M, *c d*, from unity; *viz.* since A L is ten times greater than A *c*, L M shall be the tenth term of the series from unity; and because A *e* is three times greater than A *c*, *e f* will be the third term of the series if *c d* be the first, and there shall be two mean proportionals between A B and *e f*; and between A B and L M there will be nine mean proportionals. And if the extremities of the lines B *d*, D *f*, F *h*, &c. be joined by right lines, there will be a new polygon made, consisting of more but shorter sides than the last.

If, in this manner, mean proportionals be continually placed between every two terms, the number of terms at last will be made so great, as also the number of the sides of the polygon, as to be greater than any given number, or to be infinite; and every side of the polygon so lessened, as to become less than any given right line; and consequently the polygon will be changed into a curve lined figure; for any curve-lined figure may be conceived as a polygon, whose sides are infinitely small and infinite in number. A curve described after this manner, is called logarithmical.

It is manifest from this description of the logarithmic curve, that all numbers at equal distances are continually proportional. It is also plain, that if there be four numbers, A B, C D, I K, L M, such that the distance between the first and second be equal to the distance between the third and the fourth; let the distance from the second to the third be what it will, these numbers will be proportional. For because the distances A C, I L, are equal, A B shall be to the increment D *s*, as I K is to the increment M T. Wherefore, by composition, A B : D C :: I K : M L. And, contrarywise, if four numbers be proportional, the distance between the first and second shall be equal to the distance between the third and fourth.

The distance between any two numbers is called the logarithm of the ratio of those numbers; and, indeed, doth not measure the ratio itself, but the number of terms in a given series of geometrical proportionals, proceeding from one number to another, and defines the number of equal ratios by the composition whereof the ratio of numbers are known.

LOGARITHMS, are the indexes or exponents (mostly whole numbers and decimal fractions, consisting of seven places of figures at least) of the powers or roots (chiefly broken) of a given number; yet such indexes or exponents, that the several powers or roots they express, are the natural numbers 1, 2, 3, 4, 5, &c. to 10 or 100000, &c. (as if the given number be 10, and its index be assumed 1.0000000, then the 0.0000000 root of 10, which is 1, will be the logarithm of 1; the 0.301036 root of 10, which is 2, will be the logarithm of 2; the 0.477121 root of 10, which is 3, will be the logarithm of 3; the 0.612060 root of 10, the logarithm of 4; the 1.041393 power of 10, the logarithm of 11; the 1.079181 power of 10, the logarithm of 12, &c.) being chiefly contrived for ease and expedition in performing of arithmetical operations in large numbers, and in trigonometrical calculations; but they have likewise been found of extensive service in the higher geometry, particularly in the method of fluxions. They are generally founded on this consideration, that if there be any row of geometrical proportional numbers, as 1, 2, 4, 8, 16, 32, 64, 128, 256, &c. or 1, 10, 100, 1000, 10000, &c. And as many arithmetical progressional numbers adapted to them, or set over them, beginning with 0.

$$\text{thus,}\left\{\begin{array}{llllllll}0, & 1, & 2, & 3, & 4, & 5, & 6, & 7, \&c.\\ 1, & 2, & 4, & 8, & 16, & 32, & 64, & 128, \&c.\end{array}\right\}$$

$$\text{or,}\left\{\begin{array}{llllll}0, & 1, & 2, & 3, & 4, & \&c.\\ 1, & 10, & 100, & 1000, & 10000, & \&c.\end{array}\right\}$$

Then will the sum of any two of these arithmetical progressionals, added together, be that arithmetical progressional which answers to, or stands over the geometrical progressional, which is the product of the two geometrical progressionals, over which the two assumed arithmetical progressionals stand: again, if those arithmetical progressionals be subtracted from each other, the remainder will be the arithmetical progressional standing over that geometrical progressional, which is the quotient of the division of the two geometrical progressionals belonging to the two first assumed arithmetical progressionals; and the double, triple, &c. of any one of the arithmetical progressionals will be the arithmetical progressional standing over the square, cube, &c. of that geometrical progression which the assumed arithmetical progressional stands over, as well as the one-half, one-third, &c. of that arithmetical progres-

sional, will be the geometrical progressional answering to the square root, cube root, &c. of the arithmetical progressional over it; and from hence arises the following common, though imperfect definition of logarithms; *viz.*

That they are so many arithmetical progressionals, answering to the same number of geometrical ones. Whereas, if any one looks into the tables of logarithms, he will find, that these do not all run on in an arithmetical progression, nor the numbers they answer to in a geometrical one; these last being themselves arithmetical progressionals. Dr. Wallis, in his history of algebra, calls logarithms the indexes of the ratios of numbers to one another. Dr. Halley, in the Philosophical Transactions, Number 216, says, they are the exponents of the ratios of unity to numbers. So, also, Mr. Cotes, in his "Harmonia Mensurarum," says, they are the numerical measures of ratios: but all these definitions convey but a very confused notion of logarithms. Mr. Maclaurin, in his "Treatise of Fluxions," has explained the natural and genesis of logarithms, agreeably to the notion of their first inventor, Lord Neper. Logarithms then, and the quantities to which they correspond, may be supposed to be generated by the motion of a point: and if this point moves over equal spaces in equal times, the line described by it increases equally.

Again, a line decreases proportionably, when the point that moves over it describes such parts in equal times as are always in the same constant ratio to the lines from which they are subducted, or to the distances of that point, at the beginning of those lines, from a given term in that line. In like manner, a line may increase proportionably, if in equal times the moving point describes spaces proportional to its distances from a certain term at the beginning of each time. Thus, in the first case, let *a c* (Plate IX. Miscel. fig. 1 and 2.) be to *a o*, *c d* to *c o*, *d e* to *d o*, *e f* to *e o*, *f g* to *f o*, always in the same ratio of Q R to Q S: and suppose the point P sets out from *a*, describing *a c*, *c d*, *d e*, *e f*, *f g*, in equal parts of the time; and let the space described by P in any given time, be always in the same ratio to the distance of P from *o* at the beginning of that time, then will the right line *a o* decrease proportionally.

In like manner, the line *o a* (fig. 3.) increases proportionally, if the point *p*, in equal times, describes spaces *a c*, *c d*, *d e*, *e f*, *f g*, &c. so that *a c* is to *a o*, *c d* to *c o*, *d e* to *d o*, &c. in a constant ratio. If we now suppose a point P describing the line A G (fig. 4.) with an uniform motion, while the point *p* describes a line increasing or decreasing proportionally, the line A P, described by P, with this uniform motion, in the same time that *o a*, by increasing or decreasing proportionally, becomes equal to *o p*, is the logarithm of *o p*. Thus A C, A D, A E, &c. are the logarithms of *o c*, *o d*, *o e*, &c. respectively; and *o a* is the quantity whose logarithm is supposed equal to nothing.

We have here abstracted from numbers, that the doctrine may be the more general; but it is plain, that if A C, A D, A E, &c. be supposed, 1, 2, 3, &c. in arithmetic progression; *o c*, *o d*, *o e*, &c. will be in geometric progression; and that the logarithm of *o a*, which may be taken for unity, is nothing.

Lord Neper, in his first scheme of logarithms, supposes, that while *o p* increases or decreases proportionally, the uniform motion of the point P, by which the logarithm of *o p* is generated, is equal to the velocity of *p* at *a*; that is, at the term of time when the logarithms begin to be generated. Hence logarithms, formed after this model, are called Neper's Logarithms, and sometimes Natural Logarithms.

When a ratio is given, the point *p* describes the difference of the terms of the ratio in the same time. When a ratio is duplicate of another ratio, the point *p* describes the difference of the terms in a double time. When a ratio is triplicate of another, it describes the difference of the terms in a triple time; and so on. Also, when a ratio is compounded of two or more ratios, the point *p* describes the difference of the terms of that ratio in a time equal to the sum of the times, in which it describes the difference of the terms of the simple ratios of which it is compounded. And what is here said of the times of the motion of *p* when *o p* increases proportionally, is to be applied to the spaces described by P, in those times, with its uniform motion.

Hence the chief properties of logarithms are deduced. They are the measures of ratios. The excess of the logarithm of the antecedent, above the logarithm of the consequent, measures the ratio of those terms. The measure of the ratio of a greater quantity to a lesser is positive; as this ratio, compounded with any other ratio, increases it. The ratio of equality, compounded with any other ratio, neither increases nor diminishes it; and its measure is nothing. The measure of the ratio of a lesser quantity

to a greater is negative; as this ratio, compounded with any other ratio, diminishes it. The ratio of any quantity A to unity, compounded with the ratio of unity to A, produces the ratio of A to A, or the ratio of equality; and the measures of those two ratios destroy each other when added together; so that when the one is considered as positive the other is to be considered as negative. By supposing the logarithms of quantities greater than *o a* (which is supposed to represent unity) to be positive, and the logarithms of quantities less than it to be negative, the same rules serve for the operations by logarithms, whether the quantities be greater or less than *o a*. When *o p* increases proportionally, the motion of *p* is perpetually accelerated; for the spaces *a c*, *c d*, *d e*, &c. that are described by it in any equal times that continually succeed after each other, perpetually increase in the same proportion as the lines *o a*, *o c*, *o d*, &c. When the point *p* moves from *a* towards *o*, and *o p* decreases proportionally, the motion of *p* is perpetually retarded; for the spaces described by it in any equal times that continually succeed after each other, decrease in this case in the same proportion as *o p* decreases.

If the velocity of the point *p* be always as the distance *o p*, then will this line increase or decrease in the manner supposed by Lord Neper; and the velocity of the point *p* being the fluxion of the line *o p*, will always vary in the same ratio as this quantity itself. This, we presume, will give a clear idea of the genesis, or nature of logarithms; but for more of this doctrine, see Maclaurin's Fluxions.

Logarithms, *construction of*. The first makers of logarithms, had in this a very laborious and difficult task to perform; they first made choice of their scale or system of logarithms, that is, what set of arithmetical progressionals should answer to such a set of geometrical ones, for this is entirely arbitrary; and they chose the decuple geometrical progressionals, 1, 10, 100, 1000, 10000, &c. and the arithmetical one, 0, 1, 2, 3, 4, &c. or, 0.000000; 1.000000; 2.000000; 3.000000; 4.000000, &c. as the most convenient. After this they were to get the logarithms of all the intermediate numbers between 1 and 10, 10 and 100, 100 and 1000, 1000 and 10000, &c. But first of all they were to get the logarithms of the prime numbers 3, 5, 7, 11, 13, 17, 19, 23, &c. and when these were once had, it was easy to get those of the compound numbers made up of the prime ones, by the addition or subtraction of their logarithms.

In order to this, they found a mean proportion between 1 and 10, and its logarithm will be one half that of 10; and so given, then they found a mean proportional between the number first found and unity, which mean will be nearer to 1 than that before, and its logarithm will be one half of the former logarithm, of one-fourth of that of 10; and having in this manner continually found a mean proportional between 1 and the last mean, and bisected the logarithms, they at length, after finding 54 such means, came to a number

1.00000000000000001278191493200323442

so near to 1 as not to differ from it so much as $\frac{1}{100000000000000000}$ part, and found its logarithm to be

0.000000000000000005551115123125782702

and

000000000000000012781914932003235 to be the difference whereby 1 exceeds the number of roots or mean proportionals found by extraction; and then, by means of these numbers, they found the logarithms of any other numbers whatsoever; and that after the following manner: between a given number, whose logarithm is wanted, and 1, they found a mean proportional, as above, until at length a number (mixed) be found, such a small matter above 1, as to have 1 and 15 cyphers after it, which are followed by the same number of significant figures; then they said, as the last number mentioned above, is to the mean proportional thus found, so is the logarithm above, *viz.*

0.000000000000000005551115123125782702

to the logarithm of the mean proportional number, such a small matter exceeding 1, as but now mentioned; and this logarithm being as often doubled as the number of mean proportionals, (formed to get that number) will be the logarithm of the given number. And this was the method Mr. Briggs took to make the logarithms. But if they are to be made to only seven places of figures, which are enough for common use, they had only occasion to find 25 mean proportionals, or, which is the same thing, to extract the $\frac{1}{33554432}$th root of 10. Now having the logarithms of 3, 5, 7, they easily got those of 2, 4, 6, 8, and 9; for since $\frac{10}{5}=2$, the logarithm of 2 will be the difference of the logarithms of 10, and 5 the logarithm of 4 will be two times the logarithm of 2; the logarithm of 6 will be the sum of the logarithm of 2 and 3; and the logarithm of 9 double the logarithm of 3. So, also, having found the logarithms of 13, 17, and 19, and also of 23 and 29, they did easily

get those of all the numbers between 10 and 30, by addition and substraction only; and so having found the logarithms of other prime numbets, they got those of other numbers compounded of them.

But since the way above hinted at, for finding the logarithms of the prime numbers is so intolerably laborious and troublesome, the more skilful mathematicians that came after the first inventors, employing their thoughts about abbreviating this method, had a vastly more easy and short way offered to them from the contemplation and mensuration of hyperbolic spaces contained between the portions of an asymptote, right lines perpendicular to it, and the curve of the hyperbola: for if E C N (Plate IX. fig. 5.) be an hyperbola, and A D, A Q, the asymptotes, and A B, A P, A Q, &c. taken upon one of them, be represented by numbers, and the ordinates B C, P M, Q N, &c. be drawn from the several points B, P, Q, &c. to the curve, then will the quadrilinear spaces B C M P, P M N Q, &c. *viz.* their numerical measures, be the logarithms of the quotients of the division of A B by A P, A P by A Q, &c. since when A B, A P, A Q, &c. are continual proportionals, the said spaces are equal, as is demonstrated by several writers concerning conic sections. See HYPERBOLA.

Having said that these hyperbolic spaces, numerically expressed, may be taken for logarithms, we shall next give a specimen, from the said great Sir Isaac Newton, of the method how to measure these spaces, and consequently of the construction of logarithms.

Let C A (fig. 6.) = A F be = 1, and A B = A b = x; then will $\frac{1}{1+x}$ be = B D, and $\frac{1}{1-x} = b\,d$; and putting these expressions into series, it will be $\frac{1}{1+x} = 1 - x + x^2 - x^3 + x^4 - x^5$, &c. and $\frac{1}{1-x} = 1 + x + x^2 + x^3 + x^4 + x^5$, &c. and $\frac{\dot{x}}{1+x} = \dot{x} - x\dot{x} + x^2\dot{x} - x^3\dot{x} + x^4\dot{x} - x^5\dot{x}$, &c. and $\frac{\dot{x}}{1-x} = \dot{x} + x\dot{x} + x^2\dot{x} + x^3\dot{x} + x^4\dot{x} + x^5\dot{x}$, &c. and taking the fluents, we shall have the area A F D B $= x - \frac{xx}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \frac{x^5}{5}$, &c. and the area A F $d\,b$, $= x + \frac{xx}{2} + \frac{x^3}{3} + \frac{x^4}{4} + \frac{x^5}{5}$, &c. and the sum $b\,d$ D B $= 2x + \frac{2x^3}{3} + \frac{2}{5}x^5 + \frac{2}{7}x^7 + \frac{2}{9}x^9$, &c. Now if A B, or $a\,b$, be $\frac{1}{10} = x$, C b being = 0.9, and C B = 1.1, by putting this value of x in the equations above, we shall have the area $b\,d$ D B = 0.2006706954621511 for the terms of the series will stand as you see in this table.

	Term of the series.
0.2000000000000000	= first
6666666666666	= second
40000000000	= third
285714286	= fourth
2222222	= fifth
18182	= sixth
154	= seventh
1	= eighth

0.2006706954621511

If the parts A d and A D of this area be added separately, and the lesser D A be taken from the greater d A, we shall have A d — A D $= x^2 + \frac{x^4}{2} + \frac{x^6}{3} + \frac{x^8}{4}$, &c. = 0.0100503358535014, for the terms reduced to decimals will stand thus:

	Term of the series.
0.0100000000000000	= first
500000000000	= second
3333333333	= third
25000000	= fourth
200000	= fifth
1667	= sixth
14	= seventh

0.0100503358535014

Now if this difference of the areas be added to, and subtracted from, their sum before found, half the aggregate, *viz.* 0.1053605156578263, will be the greater area A d, and half the remainder, *viz.* 0.0953101798043249, will be the lesser area A D.

By the same tables, these areas, A D and A d, will be obtained also when A B + A d are supposed to be $\frac{1}{100}$ or C B = 1.01, and C b = 0.99, if the numbers are but duly transferred to lower places, as

Term of the series.	
0.0200000000000000	= first
6666666666	= second
400000	= third
28	= fourth

Sum = 0.0200006667066694 = area b D.

Term of the series.	
0.0001000000000000	= first
50000000	= second
3333	= third

0.0001000050003333 = area A d—A D.

Half the aggregate 0.0100503358535014 = A d, and half the remainder, *viz.* 0.0099503308531681 = A D.

And so putting A B = A b = $\frac{1}{1000}$, or C B = 1.001, and C b = 0.999, there will be obtained A d = 0.0010005000333585, and A D = 0.0009995001333085.

After the same manner, if A B = A b, be = 0.2, or 0.02, or 0.002, these areas will arise.

A d = 0.2231435513142097, and
A D = 0.1823215576939546, or
A d = 0.0202027073175194, and
A D = 0.1098026272961797, or
A d = 0.002002, and A D = 0.001.

From these areas, thus found, others may be easily had from addition and subtraction only. For since $\frac{1.2}{0.8}+\frac{1.2}{0.9}=2$, the sum of the arcs belonging to the ratios $\frac{1.2}{0.8}$ and $\frac{1.2}{0.9}$ (that is, insisting upon the parts of the absciss 1.2, 0.2; and 1.8, 0.9), *viz.*

$$0.405465, \text{\&c. and } \begin{cases} \text{A D} = 0.18232, \text{\&c.} \\ \text{A } d = 0.10536, \text{\&c.} \end{cases}$$

Sum = 0.28768, &c.

$$\text{added thus, } \begin{cases} 0.40546, \text{\&c.} \\ 0.28768, \text{\&c.} \end{cases}$$

Total = 0.69314, &c. = the area of A F H G, when C G is — 2. Also since $\frac{1.2}{0.8}+2=3$, the sum 1.0986122, &c. of the areas belonging to $\frac{1.2}{0.8}$ and 2, will be the area of A F G H, when C G = 3. Again, since $\frac{2\times 2}{0.8}=5$, and $2\times 5=10$; by adding A d = 0.2231, &c. A D = 0.1823, &c. and A d = 0.1053, &c. together, their sum is 0.5108, &c. and this added to 1.0986, &c. the area of A F G H, when C G = 3. You will have 1.6093379124341004 = A F G H, when C G is 5; and adding that of 2 to this, gives 2.3025850929940457 = A F G H, when C G is equal to 10: and since $10\times 10=100$; and $10\times 100=1000$; and $\sqrt{5\times 10\times 0.98}=7$, and $10\times 1.1=11$, and $\frac{1000\times 1.091}{7\times 11}=13$, and $\frac{1000\times 0.998}{2}=499$; it is plain that the area A F G H may be found by the composition of the areas found before, when C G = 100, 1000, or any other of the numbers above-mentioned; and all these areas are the hyperbolic logarithms of those several numbers.

Having thus obtained the hyperbolic logarithms of the numbers 10, 0.98, 0.99, 1.01, 1.02; if the logarithms of the four last of them be divided by the hyperbolic logarithm 2.3025850, &c. of 10, and the index 2 be added; or, which is the same thing, if it be multiplied by its reciprocal 0.4342944819032518, the value of the subtangent of the logarithmic curve, to which Brigg's logarithms are adapted, we shall have the true tabular logarithms of 98, 99, 100, 101, 102. These are to be interpolated by ten intervals, and then we shall have the logarithms of all the numbers between 980 and 1020; and all between 980 and 1000, being again interpolated by ten intervals, the table will be as it were constructed. Then from these we are to get the logarithms of all the prime numbers, and their multiples less than 100, which may be done by addition and subtraction only: for $\frac{\sqrt[10]{84\times 1020}}{9945}=2$; $\frac{\sqrt[4]{8\times 9963}}{984}=3$; $\frac{10}{2}=5$; $\frac{\sqrt{98}}{2}=7$; $\frac{99}{9}=11$; $\frac{1001}{7\times 11}=13$; $\frac{102}{6}=17$; $\frac{998}{4\times 13}=19$; $\frac{9936}{16\times 27}=23$; $\frac{986}{2\times 17}=29$; $\frac{992}{32}=31$; $\frac{999}{27}=37$; $\frac{984}{24}=41$; $\frac{989}{23}=43$; $\frac{987}{21}=47$; $\frac{9911}{11\times 17}=53$; $\frac{9971}{13\times 13}=59$; $\frac{9882}{2\times 81}=61$; $\frac{9949}{3\times 49}=67$; $\frac{994}{14}=71$; $\frac{9928}{8\times 17}=73$; $\frac{9954}{7\times 18}=79$; $\frac{996}{12}=83$; $\frac{9968}{7\times 16}=89$; $\frac{9894}{6\times 17}=97$; and thus having the logarithms of all the numbers less

than 100, you have nothing to do but interpolate the several times through ten intervals.

Now the void places may be filled up by the following theorem. Let n be a number, whose logarithm is wanted; let x be the difference between that and the two nearest numbers, equally distant on each side, whose logarithms are already found: and let d be half the difference of their logarithms: then the required logarithm of the number n will be had by adding $d+\frac{dx}{2n}+\frac{dx^3}{12n^3}$, &c. to the logarithm of the lesser number: for if the numbers are represented by C p, C G, C P (fig. 16.) and the ordinates ps, P Q, be raised; if n be wrote for C G, and x for G P, or G p, the area p s Q P, or $\frac{2r}{n}+\frac{x^2}{2n^2}+\frac{x^3}{3n^3}$, &c. will be to the area p s H G, as the difference between the logarithms of the extreme numbers, or 2 d, is to the difference between the logarithms of the lesser, and of the middle one; which, therefore, will be

$$\frac{\frac{dx}{n}+\frac{dx^2}{2n}+\frac{dx^3}{3n}, \text{ \&c.}}{\frac{x}{n}+\frac{x^3}{3n}+\frac{x^5}{5n}, \text{ \&c.}}=d+\frac{dx}{2n}+\frac{dx^3}{12n^3}, \text{ \&c.}$$

The two first terms $d+\frac{dx}{2n}$ of this series being sufficient for the construction of a canon of logarithms, even to 14 places of figures, provided the number, whose logarithm is to be found, be less than 1000; which cannot be very troublesome, because x is either 1 or 2: yet it is not necessary to interpolate all the places by help of this rule, since the logarithms of numbers, which are produced by the multiplication or division of the number last found, may be obtained by the numbers whose logarithms were had before, by the addition or subtraction of their logarithms. Moreover, by the difference of their logarithms, and by their second and third differences, if necessary, the void places may be supplied more expeditiously, the rule beforegoing being to be applied only where the continuation of some full places is wanted, in order to obtain these differences.

By the same method rules may be found for the intercalation of logarithms, when of three numbers the logarithm of the lesser and of the middle number are given, or of the middle number and the greater; and this although the numbers should not be in arithmetical progression. Also by pursuing the steps of this method, rules may be easily discovered for the construction of artificial sines and tangents, without the help of the natural tables. Thus far the great Newton, who says, in one of his letters to M. Leibnitz, that he was so much delighted with the construction of logarithms, at his first setting out in those studies, that he was ashamed to tell to how many places of figures he had carried them at that time: and this was before the year 1666; because, he says, the plague made him lay aside those studies, and think of other things.

Dr. Keil, in his Treatise of Logarithms, at the end of his Commandine's Euclid, gives a series, by means of which may be found easily and expeditiously the logarithms of large numbers. Thus, let z be an odd number, whose logarithm is sought: then shall the numbers $z-1$ and $z+1$ be even, and accordingly their logarithms, and the difference of the logarithms will be had, which let be called y. Therefore, also the logarithm of a number, which is a geometrical mean between $z-1$ and $z+1$, will be given, *viz.* equal to half the sum of the logarithms. Now the series $y\times\frac{1}{4z}+\frac{1}{24z^3}+\frac{181}{15120z^7}+\frac{13}{25200z^9}$, &c. shall be equal to the logarithm of the ratio, which the geometrical mean between the numbers $z-1$ and $z+1$, has to the arithmetical mean, *viz.* to the number z. If the number exceeds 1000, the first term of the series, *viz.* $\frac{y}{4z}$, is sufficient for producing the logarithm to 13 or 14 places of figures, and the second term will give the logarithm to 20 places of figures. But if z be greater than 10000, the first term will exhibit the logarithm to 18 places of figures: and so this series is of great use in filling up the chiliads omitted by Mr. Briggs. For example, it is required to find the logarithm of 20001: the logarithm of 20000 is the same as the logarithm of 2, with the index 4 prefixed to it; and the difference of the logarithms of 20000 and 20001, is the same as the difference of the logarithms of the numbers 10000 and 10001, *viz.* 0.0000434272, &c. And if this difference be divided by 4 z, or 80004, the quotient $\frac{y}{4z}$ shall be

0.000000000542813; and if the logarithm of the geometrical mean, *viz.* 4.301051709302416 be added to the quotient, the sum will be

4.301051709845230 = the logarithm of 20001.

Wherefore it is manifest, that to have the logarithm to 14 places of figures, there is no necessity of continuing out the quotient beyond 6 places of figures. But if you have a mind to have the logarithm to 10 places of figures only, the two first figures are enough. And if the logarithms of the numbers above 20000 are to be found by this way, the labour of doing them will mostly consist in setting down the numbers. This series is easily deduced from the consideration of the hyperbolic spaces aforesaid. The first figure of every logarithm towards the left hand, which is separated from the rest by a point, is called the index of that logarithm; because it points out the highest or remotest place of that number from the place of unity in the infinite scale of proportionals towards the left hand: thus, if the index of the logarithm be 1, it shows that its highest place towards the left hand is the tenth place from unity; and therefore all logarithms which have 1 for their index, will be found between the tenth and hundredth place in the order of numbers. And for the same reason all logarithms which have 2 for their index, will be found between the hundredth and thousandth place in the order of numbers, &c. Whence universally the index or characteristic of any logarithm is always less by one than the number of figures in whole numbers, which answer to the given logarithm; and, in decimals, the index is negative.

As all systems of logarithms whatever are composed of similar quantities, it will be easy to form, from any system of logarithms, another system in any given ratio; and consequently to reduce one table of logarithms into another of any given form. For as any one logarithm in the given form is to its correspondent logarithm in another form, so is any other logarithm in the given form to its correspondent logarithm in the required form; and hence we may reduce the logarithms of Lord Neper into the form of Briggs's, and contrarywise. For as 2.302585092, &c. Lord Neper's logarithm of 10, is to 1.0000000000, Mr. Briggs's logarithm of 10; so is any other logarithm in Lord Neper's form to the correspondent tabular logarithm in Mr. Briggs's form: and because the two first numbers constantly remain the same, if Lord Neper's logarithm of any one number be divided by 2.302585, &c. or multiplied by .4342944, &c. the ratio of 1.0000, &c. to 2.30258, &c. as is found by dividing 1.00000, &c. by 2.30258, &c. the quotient in the former, and the product in the latter, will give the correspondent logarithm in Briggs's form, and the contrary. And, after the same manner, the ratio of natural logarithms to that of Briggs's will be found = 868588963806.

The use and application of Logarithms. It is evident, from what has been said of the construction of logarithms, that addition of logarithms must be the same thing as multiplication in common arithmetic; and subtraction in logarithms the same as division: therefore, in multiplication by logarithms, add the logarithms of the multiplicand and multiplier together, their sum is the logarithm of the product.

		num.	logarithms.
Example.	Multiplicand..	8.5	0.9294189
	Multiplier.......	10	1.0000000
	Product..........	85	1.9294189

And in division, subtract the logarithm of the divisor from the logarithm of the dividend, the remainder is the logarithm of the quotient.

		num.	logarithms.
Example.	Dividend...	9712.8	3.9873444
	Divisor......	456	2.6589648
	Quotient...	21.3	1.3283796

Logarithm, *to find the complement of a.* Begin at the left hand, and write down what each figure wants of 9, only what the last significant figure wants of 10; so the complement of the logarithm of 456, *viz.* 2.6589648, is 7.3410352.

In the rule of three. Add the logarithms of the second and third terms together, and from the sum subtract the logarithm of the first, the remainder is the logarithm of the fourth. Or, instead of subtracting a logarithm, add its complement, and the result will be the same.

Logarithms, *to raise powers by.* Multiply the logarithm of the number given by the index of the power required, the

product will be the logarithm of the power sought.

Example. Let the cube of 32 be required by logarithms. The logarithm of 32 = 1.5051500, which, multiplied by 3, is 4.5154500, the logarithm of 32768, the cube of 32. But in raising powers, *viz.* squaring, cubing, &c. of any decimal fraction by logarithms, it must be observed, that the first significant figure of the power be put so many places below the place of units, as the index of its logarithm wants of 10, 100, &c. multiplied by the index of the power.

Logarithms, *to extract the roots of powers by.* Divide the logarithm of the number by the index of the power, the quotient is the logarithm of the root sought.

To find mean proportionals between any two numbers. Subtract the logarithm of the least term from the logarithm of the greatest, and divide the remainder by a number more by one than the number of means desired; then add the quotient to the logarithm of the least term (or subtract it from the logarithm of the greatest) continually, and it will give the logarithms of all the mean proportionals required.

Example. Let three mean proportionals be sought, between 106 and 100.

Logarithm of 106 = 2.0253059
Logarithm of 100 = 2.0000000

Divide by 4)0.0253059(0.0063264.75

Logarithm of the least term 100 added		2.0000000
Logarithm of the first mean . . .	101.4673846	2.0063264.75
Logarithm of the second mean .	102.9563014	2.0126529.5
Logarithm of the third mean . .	104.4670483	2.0189794.25
Logarithm of the greatest term .	106	2.0253059

LOGIC, the art of reasoning. As the necessities of our existence oblige us to think, and to arrange our thoughts in such a manner as may enable us to communicate with each other, we are habitually impelled towards a conclusion, that it is unnecessary to teach reasoning as an art. It is hardly needful to combat this notion by arguments which will easily occur to most men of reflection; and indeed the contrary persuasion was so prevalent in the middle ages, that men seem to have been more occupied with the art, than with the proper use of it.

In order to reason well, it is necessary that the nature of our perceptions and ideas, and the notions or conclusions we draw from them, should be well understood. Logic, therefore, is a science of extensive occupation; which has its beginning in the constitution of things, and the processes of the human intellect, and its practical termination in the structure, use, and application of language. Its objects are no less than the universal acquisition of knowledge, and that mutual communication which constitutes a large part of the employment, and is the most distinguishing character of man.

The impressions made by external objects upon the senses, are called sensations or ideas of sensation. See Ideology. The recollection or remembrance of those sensations are simply called ideas. The general notions which are produced in the mind by reflecting upon ideas have been called ideas of reflection; but as they all grow out of the comparison of the first-mentioned ideas, and do universally in the last result imply propositions, it appears much preferable to call them notions.

Logical writers divide ideas into simple and complex; but as we have no simple sensations, and can therefore have no simple ideas but by the artificial process of abstraction, the division seems useless. The word complex here signifies compounded, and the compounded nature of our ideas will practically depend, in a great measure, upon our choice or determination in the subject of our reasoning. Thus, a lemon is soft, fragrant, yellow, and acid. If I throw a lemon at another, the attention will be chiefly directed to the organ of touch, and its fragrance, its tint, and its acidity, will be abstracted or left out. But the perfumer, the designer, and the chemist, would separately attend to those parts of the idea which were suggested by the organs of smell, of vision, and of taste. And in this manner it is that we may separate the simple ideas of yellowness, acidity, and fragrance; though, in nature, their causes never appear insu-

lated and apart from those of all the other sensations.

Abstraction, or the leaving out parts of ideas or notions; generalization, or classing things together, as possessing the remaining distinctive characters; composition, or the re-assumption of some of the abstracted or rejected ideas, are the voluntary acts of the mind, adopted in order to facilitate the useful process of comparison. Thus we may abstract from bodies all ideas but those of structure, and divide them into organized and unorganized; or we may take the organized bodies, and call them animals and vegetables; or we may attend to their place of existence, and call them terrestrial, aquatic, volatile, and the like; and many of our most useful propositions will thus, in all our mental operations, continue equally general and abstracted.

In the scientific arrangement of natural objects, philosophers have pursued the course of abstraction, until, by rejecting all the ideas capable of affording the distinctive characters of individuals, they arrived at an hypothetical being called substance. Much has been written concerning it; but it will perhaps be attended with the least obscurity to say, that it is supposed to be an independent existence, which serves as the basis or support to those properties which are perceived by our senses; or, in the words of logicians, it is the subject of modes and accidents.

The modes of substance are those distinguishable objects of sense which might, if separate, produce simple ideas. Thus, softness, fragrance, yellowness, and acidity, are among the modes which co-exist in the subject or substance, lemon. Many distinctions are made in modes. They are called essential or accidental, absolute or relative, &c. The moderns appear to use the words properties of bodies, and powers and laws of nature, with much more distinctness than the earlier logicians did their modes and accidents.

Words are intended to be the signs of things, but are very far from being so. If our ideas were adequate representations of the things which cause them, which they are not; if they were not of necessity mutilated by abstraction, and there were not a continual exertion in language to emulate the rapidity of thought, then might words obtain the supposed resemblance. But the boasted extent and perspicuity of the intellect of man proceeds but a little beyond the signs and tones of those inferior animals who are supposed to have no power of conversing. And even if we could vanquish the insuperable difficulties which impede our clear mutual communication, what are the grounds of our knowledge? they are very limited, and often fallacious.

Knowledge consists in the determination of those modes of surrounding beings which are taken to be permanent, and of those which are observed to vary. The former are chiefly of the nature of quantity and position, and the latter seem resolvable into motion. Mathematical science appears to comprehend the whole of the first; and the latter, which embraces by far the greater part of what concerns our existence and well-being, is included in those histories of events upon which we establish our principles of cause and effect. Abstraction, or analysis, can give us very clear notions of the subjects of mathematics; and in these alone it is that we find absolute proof or demonstration. But in all the rest of our knowledge the facts are complex, obscure, and of uncertain evidence; and the principal, nay the only, ground of our reliance upon our doctrines respecting them is, that our predictions are in many instances verified.

Words being constructed and established by mere usage, are not only inadequate and contracted in their use, but equivocal and synonimous; that is to say, one word may be used to denote several distinct and different things; as when we speak of a beam of light, a beam of timber, or the beam of a pair of scales; or, on the contrary, as when we speak of an house, an habitation, or a residence. It must be admitted, however, that there are few synonymes in the practice of those who are masters of a language; because few words are consecrated by usage to precisely the same meaning.

Many acute and useful disquisitions have been written upon language and universal grammar. See Language.

Since our idea of a thing must be composed or made up of all the simple ideas which that thing can produce by our perceptions, and this will for the most part be inadequate, the word, denomination, or name of a thing, must be the sign of that idea, liable to such additional error as may arise from any improper use that may be made of it. And as by abstraction we generalize our ideas and notions, and afterwards comprehend and compare them at our pleasure; so in the construction of language a like order is followed in words. Thus we may arrange things,

from their similitude, under classes more or less abstracted as to their modes, calling these classes by the names of genera and species. And in the names of things, we shall have not only to regard this arrangement, but likewise the appropriation and correct use of the denomination itself. If we had terms for all simple ideas, and were to enumerate in due order all the simple ideas subsisting in a thing, that enumeration would constitute what is called a definition of the thing; and simple ideas would be, as in strictness they are, undefinable. But since all our sensations are complex, the relations of simple ideas with regard to each other, as residing in the same subject, will afford the means of indicating them. Thus, light is that by which the organ of vision is acted upon, and the word is therefore defined or indicated from that organ. Colour is a mode of light perhaps too simple to be defined, but clearly indicable from any natural subject in which it may subsist; as, for example, green is the colour of grass, red is the colour of a rose, and yellow the colour of an orange.

Thus, then, the nature of terms, or words, is fixed by definition; a thing for the most part of extreme difficulty, as, from our ignorance of things, and the complexity of the objects comprehended by usage under any term, it can in few cases be done. The arrangement of things is by genera, where the same class of beings agree in a few attributes only; and by species, where they agree in more; and these genera and species may be subordinate to each other in numerous pairs, the genus immediately above each species being called the proximate genus. And from this ordinary arrangement logicians obtain a ready method of defining from the specific difference, which, though certainly much less adequate than those of the mathematicians, is nevertheless very useful. That is to say, the genus and the specific difference is held to constitute the definition of the species. Thus, if the words, 1. animal; 2. four-footed; 3. graminivorous; and, 4. fleece-bearing; be the arrangement of certain beings possessing life, we should define the first genus from the only character left by the abstraction, namely, that it is a being possessing life; and the first species would be admitted to be well defined by the words four-footed animal (named quadruped); the second, by the words graminivorous quadruped (named cattle); and the third by the words fleece-bearing cattle (named sheep): or we might less conveniently go through the whole series, and call the sheep a fleece-bearing, graminivorous, four-footed animal.

Logicians also avail themselves in defining, where practicable, of some striking attribute called the essence of a thing. Thus, under the genus, measure, the species, bushel, peck, quartern, &c. are essentially distinguished by the respective magnitudes which are capable of being numerically expressed.

All our knowledge is contained in propositions, and every proposition consists of three parts. Thus in the proposition, "Snow is white," there are three parts or terms, *snow*, which is called the subject; *is* which is called the copula; and *white*, which is called the predicate. If the proposition agree with the nature of things, it is true, if not, it is false. All propositions are reducible to this form, though both the subject and predicate may be expressed by many words; but the copula will always be some inflexion of the verb *to be*, with the word *not* if the proposition be negative.

Propositions which contain either a plurality of predicates or of subjects, or which manifest a compounded nature in either, have been called compound propositions. In the first, however, the proposition seems merely to be a number of propositions conjoined, &c.; in the latter, the form of words may be considered as forming a definition of the words or terms. Thus, "John and Thomas departed." includes the propositions, "John was departing, and Thomas was departing." And again the proposition, "Water frozen in flakes as it falls from the atmosphere *is* coloured like the powder of pure dry salt," is evidently the same proposition as was first given, excepting that it contains a definition of the word *snow*, taken from its formation, and of the word *whiteness*, from a substance of which it is one of the modes.

Our limits will not permit us to enter into the form of propositions, from which they are denominated copulative, casual, relative, or disjunctive or modal; as where a proposition itself becomes the subject, or positive, or negative, and so forth. These distinctions are in few cases useful, and in many tedious, trifling, and deceptive.

Truth is determined either intuitively; as when the relation between the predicate and its subject is immediately seen and admitted. So "the whole is equal to all its parts:"—and these simple truths are called axioms:—

Or else it is determined demonstratively; so the proposition, "the opposite angles made by right lines crossing each other are equal," is not intuitive, but requires to be demonstrated by a succession of axioms connected together:

Or lastly, it is determined analogically, upon the probability that what has happened will, in like circumstances, happen again. Thus, upon the probability that bodies will continue to fall to the ground; that violent motion will be followed by heat; that similar inducements or motives will be followed by similar acts in men; we found the doctrine of cause and effect, and establish our knowledge of physical and moral history, so as to give credit to the past, and confidence in many respects to the future.

It is evident that analogical propositions have much less certainty than those of intuition or demonstration.

Though in our investigations of truth we must necessarily have recourse to observations of individual objects and events, as the ground-work of all; yet, in our inductions, reasonings, proofs, and processes of instruction, we proceed from generals to individuals. And as, in strict demonstration, the subject and predicate of a proposition are connected by a train of axioms,—so, in every other argumentation, it will be the endeavour of a wise man to follow the same course as nearly as may be possible. But, from the confusion arising from the relations of the complicated objects of social intercourse, and from the rapidity of language with its abridgments and transpositions, so many things are left to be understood—that it is not often an easy task to show, whether the reasoner does really pursue the course of pure argumentation, or whether he deceives himself or others. Logicians have therefore adopted a formal arrangement for each of the steps of comparison, which they call a syllogism; not calculated indeed for the discovery of remote truths from the use and application of the more immediate or intuitive, but well calculated to give regularity to the mind by scientific discipline, and to shorten controversy, by a clear detection of the component parts of false reasoning. And here, by the way, it may be remarked, that the inexplicable disorder of the logical reasonings of the middle ages is less to be attributed to the nature of their science of reasoning, loaded as it was with needless distinctions, than to their theological and psychological dogmas, and the delusions into which they wandered with regard to the objects called transcendental; delusions, which a sound and bold application of their own science, if it could have been dared, would not have confirmed, but overthrown.

But to return; the syllogism consists of three propositions. In the first, called the major proposition, something is predicated of a general subject: in the second, called the minor, the subject of the major becomes the predicate of a specific subject: and in the third, called the conclusion, the predicate of the general subject is applied to the specific. Thus,

Major. All men are fallible.
Minor. The Pope is a man;
Conclusion. Therefore the Pope is fallible.

The major and minor terms are often called the premises, and the minor is sometimes called the argument. The premises are supposed to be intuitive, or at least incontestable, and the conclusion is established upon the axiom, that whatever can be predicated or affirmed of a genus, may also be predicated of every species comprehended under it; and the like of species, and the individuals comprehended under them.

It is usual to denominate the two subjects, and the predicate, terms of the syllogism The generic word or sentence is called the middle term; its predicate is the major term; and the specific word or sentence is called the minor term. Thus, in the preceding syllogism the three terms are

Major term. Fallible.
Middle term. All men.
Minor term. The Pope.

Here it is not pretended, that all men should upon every occasion reason according to the rules of logic, any more than that a writer should upon all occasions insert each individual member of a sentence, and leave nothing to be supplied or understood. But as the man who is a sound grammarian can analyse and parse every member of a sentence, and will write with order, precision, and correctness; so will the logician, who is able to arrange the parts of an argument in mood and figure, be quick in discerning the imperfect, defective, or inadmissible assertions, and will so dispose his own notions and principles, that his proofs shall be conclusive and clear. The works even of mathematical writers would, in many instances, be benefitted by this severity of conduct; and there are few indeed which might not be rendered more

perfect by strict logical examination and correction.

Mood and figure are words applied by logical writers to denote the arrangement of the terms of a syllogism. It is done by the use of the letters A, E, I, O, of which A denotes universal affirmative; E, universal negative; I, particular affirmative; and O, particular negative. But as it would be difficult to retain in the memory the various changes in the order of these letters, if prefixed to the three parts of a syllogism, fourteen artificial words have been formed, of three syllables each, containing the vowels so to be prefixed in the order of the mood to be denoted by each word. The fourteen moods are classed under these different figures, by which terms logicians mean to denote the particular situation of the middle term, with respect to the major and minor. The first figure is distinguished by the middle term being the subject of the major, and predicate of the minor proposition, and its four moods are denoted by the words *Barbara, Celarent, Darii, Ferio.* The second figure admits of negative conclusions only, the major being always universal, and one of the premises negative. Its moods are *Cesare, Camestres, Festino, Baroco.* And in the third figure the middle term is the subject of both premises, the minor affirmative, and the conclusion particular. Its moods are *Darapti, Felapton, Disamis, Datisi, Bocardo, Ferison.* We shall not extend our article to exemplify these moods, nor shall we proceed to give instances of the form and complexities of syllogisms, which systematic writers have been more solicitous to enumerate and name, than to analyze and develope. In like manner we shall pass over the consideration of the various sophisms treated of by them, because these objects would lead us too far, and their detection follows immediately upon a statement of the premises and conclusions according to rule. And upon the whole, we shall conclude by observing, that though the old logic was burdensome, from the manner in which it had been suffered to enlarge itself, yet, since much of our present modes of reasoning, and of the expressions made use of at the bar, in the senate, and among our best writers, are derived from its rules, and since the moderns, when they decried and rejected it, have not been solicitous to establish any determinate or correct system, we deem it entitled to more attention than has usually been paid to it.

LOGISTIC *curve*, the same with that otherwise called logarithmic. See LOGARITHMIC.

LOGISTIC *spiral*. See LOGARITHMIC and SPIRAL.

LOGISTICA *numeralis*, the same with algorithm. See ALGORITHM.

LOGISTICAL *arithmetic*, the doctrine of sexagesimal fractions. See SEXAGESIMALS.

LOGOGRAPHY, a method of printing, in which the types, instead of answering only to a single letter, are made to correspond to whole words. The properties of the logographic art are, 1. That the compositor shall have less charged upon his memory, than in the common way. 2. It is much less liable to error. 3. The type of each word is as easily laid hold of as that of a single letter. 4. The decomposition is much more readily performed. 5. No extraordinary expense, nor greater number of types, is required in the logographic, than in the common method of printing.

LOLIUM, in botany, *ray grass*, a genus of the Triandria Digynia class and order. Natural order of Gramineæ, or grasses. Essential character: calyx one-leafed, fixed, many-flowered. There are five species.

LOMENTACEÆ, in botany, the name of the thirty-third order in Linnæus's Fragments of a Natural Method, consisting of plants, many of which furnish beautiful dyes, and the pericarpium of which, universally a leguminous pod, contains seeds that are farinaceous or meally like those of the bean. The cassia, wild senna; hæmatoxylon, logwood; mimosa, sensitive plant, &c. are of this order.

LOMONITE, in mineralogy, is of a snow white colour, with a slight tendency to reddish white. It occurs massive; the fracture is foliated, and the surface of the folia are streaked, which gives a peculiar glimmering aspect to the surface of the fossil; it is easily frangible, and not heavy: when preserved from the air it has a slight degree of coherence; but if it is exposed to the action of that fluid, the folia spontaneously separate from each other, and it is soon reduced to a heap of unconnected parts. It forms a kind of jelly with acids, and is found in the lead mines of Huelgoet in Lower Brittany. It received its name from Gillet Laumont, who discovered it about twenty years ago.

LONCHITES, in botany, a genus of the Cryptogamia Filices class and order. Na-

tural order of Filices, or ferns. Generic character: capsule disposed in lunulated lines, lying under the sinuses of the frond. There are five species, all natives of very hot climates.

LONCHURUS, in natural history, a genus of fishes of the order Thoracici. Generic character: the head scaly; ventral fins separate; the tail lanceolated. The bearded lonchurus is a native of Surinam, about twelve inches in length, has a slightly lengthened nose, two beards at the lower jaw, and the first ray of the ventral fins elongated into a bristle. Its colour is a ferruginous brown.

LONG (ROGER,) D. D. Master of Pembroke-hall in Cambridge, Lowndes's professor of astronomy in that university, &c. was author of a well known and much approved treatise of astronomy, and the inventor of a remarkably curious astronomical machine. This was a hollow sphere of eighteen feet diameter, in which more than thirty persons might sit conveniently. Withinside the surface, which represented the heavens, was painted the stars and constellations, with the zodiac, meridians, and axis parallel to the axis of the world, upon which it was easily turned round by a winch. He died December 16, 1770, at ninety-one years of age.

A few years before his death, Mr. Jones gave some anecdotes of Dr. Long, as follows: "He is now in the 88th year of his age, and for his years vigorous and active. He was lately put in nomination for the office of vice-chancellor: he executed that trust once before, I think in the year 1737. He is a very ingenious person, and sometimes very facetious. At the public commencement, in the year 1713, Dr. Greene (master of Bennet College, and afterwards Bishop of Ely) being then vice-chancellor, Mr. Long was pitched upon for the tripos performance: it was witty and humorous, and has passed through divers editions. Some that remembered the delivery of it, told me, that, in addressing the vice-chancellor, (whom the university wags usually styled Miss Greene) the tripos orator, being a native of Norfolk, and assuming the Norfolk dialect, instead of saying, 'Domine vice-cancellarie,' archly pronounced the words thus, 'Domina vice-cancellaria;' which occasioned a general smile in that great auditory. His friend, the late Mr. Boufoy, of Ripton, told me this little incident: That he and Dr. Long, walking together in Cambridge, in a dusky evening, and coming to a short post fixed in the pavement, which Mr. Boufoy, in the midst of chat and inattention, took to be a boy standing in his way, he said, in a hurry, 'Get out of my way, boy.' 'That boy, sir,' said the Doctor, very calmly and slyly, 'is a post-boy, who turns out of his way for nobody.' I could recollect several other ingenious repartees, if there were occasion. One thing is remarkable, he never was a hale and hearty man, always of a tender and delicate constitution, yet took great care of it; his common drink water; he always dines with the fellows in the hall. Of late years he has left off eating flesh-meats; in the room thereof puddings, &c. sometimes a glass or two of wine."

LONGEVITY, the continuance of life beyond its ordinary period of duration. The term of human life does not in general much exceed 80 years, but it is well known that instances occasionally occur of persons living to the age of 100 years and upwards. Such instances, however, have not excited that general attention, which from the nature of the subject might be expected, and it is only of late years that any extensive collection of them has been formed, or attempts made to ascertain the circumstances and situations in which the different individuals preserved their lives to an age so much beyond the usual lot of man. The most extensive catalogue of this kind, is that published by J. Easton, which, though very defective, contains the names and some particulars of 1712 persons, who had attained to a century and upwards, having died at the following ages:

From 100 to 110 years	1310
110 to 120	277
120 to 130	84
130 to 140	26
140 to 150	7
150 to 160	3
160 to 170	2
170 to 185	3
	1712

The circumstances which chiefly tend to promote longevity may be reduced to the following heads:

1. *Climate.* A large majority of the recorded instances of great age were inhabitants of Great Britain or Ireland, of France, Germany, or the north of Europe, from which it appears, that moderate or even cold climates are the most favoura-

ble to long life. Heat relaxes and enfeebles, while cold consolidates and strengthens the human frame. The diet also of hot countries is less nourishing than that of cold ones; and there is generally a greater disposition, and greater opportunities to indulge in various excesses in the former, than in the latter. There are however a few instances of natives of very hot climates having attained to great age, but they have been chiefly negroes in the West Indies and America, whose ages were probably not very correctly ascertained.

2. *Parentage.* Being born of healthy parents, and exempted from hereditary disease, are circumstances evidently favourable to the duration of life; and numerous instances warrant the opinion, that longevity prevails in some families more than in others, or that descent from long-lived ancestors is one of the circumstances which give the greatest probability of attaining to extreme old age.

3. *Form and size of the individual.* It is generally admitted, that persons of a compact shape, and of a moderate stature, are the most likely to live long. Tall persons frequently acquire a habit of stooping, which contracts the chest, and is a great impediment to free respiration; whereas the short sized find little difficulty in keeping themselves erect, and are naturally much more active, by which the animal functions are retained in a state of greater perfection; the only disadvantage attending a short stature is, that it is frequently accompanied with corpulence, which is rather unfavourable to long life.

4. *Disposition of Mind.* Nothing is more conducive to longevity than to preserve equanimity and good spirits, and not to sink under the disappointments of life, to which all, but particularly the old, are necessarily subjected. This is a point which cannot be too much inculcated, as experience continually shows that many perish from despondency, who, if they had preserved their spirits and vigour of mind, might have survived many years longer. Neither the irritable, who are agitated by trifles, nor the melancholy, who magnify the evils of life, can expect to live long. Even those who suffer their strength and spirits to be exhausted by severe study, or other mental exertions, seldom reach great age. In the list before referred to, of 1712 persons who lived about a century, Fontenelle (who did not quite reach 100 years) is the only author of any note; and his great age is ascribed to the tranquil ease of his temper, and that liveliness of spirits for which he was much distinguished. Among those who have devoted themselves to the study or practice of music, a profession which encourages cheerfulness of mind, instances of great age have been very frequent.

5. *Occupation.* No person that leads an idle life will ever attain to great age; but health and long life must depend much on the manner in which the individual is employed. Those occupations are certainly the most conducive to the duration of life, which are carried on in the open air, and require activity or labour; thus farmers, gardeners, and labourers in the country, are in general the longest lived. Foot soldiers, also, who have survived the dangers of war, are remarkable for long life: they are generally stout and vigorous men, and the regularity to which surviving soldiers must have accustomed themselves, whilst their careless and disorderly companions have dropped off, the erect posture to which they have been trained, and being of course men well formed by nature, and habituated to walk well (by which they enjoy the most natural exercise in perfection) all combine in their favour. Sailors also would furnish many instances of longevity, if comfortably provided for in their old age; of this a striking proof is given in the accounts drawn up by Dr. Robertson of the pensioners in Greenwich Hospital. In the year 1801, the complement of in-pensioners was 2410, of whom there were 96 of the age of 80 years and upwards; of this number 13 were above 90 years of age, and one man 102 years old. The number of out-pensioners was about 2500, of whom it appeared there were only 23 from 80 years of age and upwards. Of the former therefore about 4 in 100 survived 80 years of age, but of the latter not 1 in 100 attained that age, a sufficient evidence of the benefits of regularity and ease in the advanced period of life, and of the attention paid to the health of the in-pensioners at that excellent institution.

6. *Mode of Living.* If persons were to live with the simplicity of ancient times, it is probable that they would attain long life, without experiencing any material illness, merely by a proper attention to air, exercise, clothing, and diet. But in the present state of society, the great bulk of the community follow, not a natural, but an artificial, mode of life, and thence are perpetually exposed to various temptations, which they find it difficult always to resist, and to dangers which they can-

not always avoid. Most persons however have it in their power in some degree to regulate their manner of living by their own choice; and by a little attention to their food, clothing, employment, rest, and temper of mind, might not only contribute materially to the prolongation of their lives, but preserve themselves from many diseases, and greatly increase their relish for all the enjoyments of life.

The importance of wholesome food, for the preservation of health and promoting long life, and the avoiding of excess, whether in eating or drinking, is sufficiently obvious. Some instances, indeed, are recorded of persons who have continued to commit excesses, and have lived long; but these are to be considered in no other light than as exceptions to a general rule; and it may reasonably be contended, that if such persons lived to a great age, notwithstanding their intemperance, they would have lived much longer had they followed a different course. Experience will point out those articles of food which are best adapted to the constitution of each individual, and there cannot be a better rule than to adhere to them as far as circumstances will permit. It may be observed, however, that people in general, especially those who do not labour, eat much more than nature requires; that a little abstinence or self-denial may often be of use, either to prevent or to cure disease; and at any rate, that none but hard working people, the young who are growing fast, or persons who are travelling about, should eat more than one full meal each day.

As to clothing, much must depend on situation and climate; but it is generally found a useful practice to wear woollens next the skin. It is remarked in many parts of Scotland, that since the use of flannel shirts has been given up by the lower orders, the rheumatism, and other diseases formerly unknown, have become very frequent, and are daily increasing. In the West India islands, if care be taken to make the troops wear flannel shirts, they are generally exempt from various disorders, which otherwise would probably have attacked them. Even the negroes themselves are said to prefer flannel to cotton or linen, and find it a much more comfortable and useful dress.

Exercise cannot be too much recommended; and as the inhabitants of large towns, and persons engaged in sedentary occupations, cannot take all the exercise abroad that may be necessary for their health, they ought as much as possible to accustom themselves to be walking about even in their own house, for though this practice does not make up for the want of exercise abroad, it is certainly the best substitute for it. Exercise is attended with the advantage of creating an inclination to retire early to rest, and of inducing sound sleep. Every one should take all the repose that nature requires, but should never continue long in bed without sleeping. Early rising, even if carried to an extreme, is far more conducive to health and long life, than late hours at night and slumbering in bed in the morning.

There is nothing that can tend more to long life than for a person to obtain a complete command of his passions, and in particular to preserve his mind from being ruffled by the occurrences of life. Perhaps there is no maxim more likely to promote good health, and consequently the duration of life, than that of paying a proper attention to temper, temperance, and sleep. By good temper the mind is preserved from disease; and by temperance, the body; and both the mind and the body, when exhausted, are again recruited and restored to their former strength, by a sufficient quantity of repose.

LONGIMETRY, the art of measuring lengths, both accessible, as roads, &c. and inaccessible, as arms of the sea, &c. See Surveying.

LONGITUDE *of a star*, in astronomy, an arch of the ecliptic, intercepted between the beginning of Aries and the point of the ecliptic cut by the star's circle of longitude. See Circle, &c.

Longitude *of a place*, in geography, is an arch of the equator intercepted between the first meridian, and the meridian passing through the proposed place; which is always equal to the angle at the pole, formed by the first meridian and the meridian of the place.

The first meridian may be placed at pleasure, passing through any place, as London, Paris, Teneriffe, &c. but among us it is generally fixed at London, or rather Greenwich, and the longitudes counted from it will be either east or west, according as they lie on the east or west side of that meridian. The difference of longitude between two places upon the earth is an arch of the equator, comprehended between the two meridians of these places; and the greatest possible is 180 degrees, when the two places lie on opposite meridians.

Since the parallels of latitude always decrease, the nearer they approach the pole, it is plain a degree upon any of

them must be less than a degree upon the equator, in the ratio of the co-sine of the latitude to the radius. Hence, as the radius is to the co-sine of any latitude; so is the minutes of difference of longitude between two meridians, or their difference in miles upon the equator, to the distance of these two meridians on the parallel of that latitude, in miles. And, by this theorem, is the following table constructed.

A TABLE,

Shewing how many miles answer to a Degree of Longitude, at every Degree of Latitude.

D.L.	Miles.	D.L.	Miles.	D.L.	Miles.	D.L.	Miles.
1	59.99	24	54.81	47	40.92	69	21.50
2	59.97	25	54.38	48	40.15	70	20.52
3	59.92	26	53.93	49	39.36	71	19.54
4	59.86	27	53.46	50	38.57	72	18.55
5	59.77	28	52.97	51	37.76	73	17.54
6	59.67	29	52.47	52	36.94	74	16.53
7	59.56	30	51.96	53	36.11	75	15.52
8	59.42	31	51.43	54	35.27	76	14.51
9	59.26	32	50.88	55	34.41	77	13.50
10	59.08	33	50.32	56	33.55	78	12.48
11	58.89	34	49.74	57	32.68	79	11.45
12	58.68	35	49.15	58	31.79	80	10.42
13	58.46	36	48.54	59	30.90	81	9.38
14	58.22	37	47.92	60	30.00	82	8.35
15	57.95	38	47.28	61	29.09	83	7.32
16	57.67	39	46.62	62	28.17	84	6.28
17	57.37	40	45.95	63	27.24	85	5.23
18	57.06	41	45.28	64	26.30	86	4.18
19	56.73	42	44.59	65	25.36	87	3.14
20	56.38	43	43.88	66	24.41	88	2.09
21	56.01	44	43.16	67	23.44	89	1.05
22	55.63	45	42.43	68	22.48	90	0.00
23	55.23	46	41.68				

LONGITUDE, in navigation, the distance of a ship or place, east or west, from another, reckoned in degrees of the equator. As the discovery of a method to find the longitude would render voyages safe and expeditious, and also preserve ships and the lives of men, the following rewards have been offered by act of parliament, as an encouragement to any person who shall discover a proper method for finding it out: the author or authors of any such method shall be entitled to the sum of 10,000*l.* if it determines the longitude to one degree of a great circle; to 15,000*l.* if it determines the same to two-thirds of that distance; and to 20,000*l.* if it determines the same to one-half of the same distance; and that half of the reward shall be due and paid when the commissioners of the navy, or the major part of them, agree that any such method extends to the security of ships within 80 geographical miles of the shores, which are places of the greatest danger; and the other half, when a ship, by the appointment of the said commissioners, or the major part of them, shall thereby actually sail over the ocean, from Great Britain to any such port in the West Indies as those commissioners, or the major part of them, shall choose for the experiment, without losing their longitude beyond the limits before-mentioned. The French, Dutch, Spaniards, and other nations, have likewise offered rewards for the same purpose.

Since, by the motion of the earth round its axis, every point upon its surface describes the circumference of a circle, or 360°, in twenty-four hours time, it is plain it must describe 15° in one hour, because $\frac{360}{24} = 15$. Hence the difference of longitude may be converted into time, by allowing one hour for every 15 degrees, and proportionally for minutes; also difference of time may be converted into difference of longitude by allowing 15° for every hour, and proportionally for a greater or less time. Consequently, by knowing the one, we can easily find the other.

Whatever contrivance, therefore, shows the hours of the day, at the same absolute point of time, in two different places, likewise serves to find the difference of longitude between those places. Now, since an eclipse of the moon proceeds from nothing else but an interposition of the earth between her and the sun, by which means she is prevented from reflecting the light she would otherwise receive from the sun, the moment that any part of her body begins to be deprived of the solar rays, it is visible to all those people who can see her at the same time; whence, if two or more different people, at two or more different places, observe the times when it first began or ended, or note the time when any number of digits was eclipsed, or when the shadow begins to cover or quit any remarkable spot, the difference of those times (if there be any), when compared together, will give the difference of longitude between the places of observation.

The longitudes of places may also be determined from the observations of solar eclipses; but these being encumber-

ed with the considerations of parallaxes, are not near so proper as those of the moon; and each of these happening but rarely, another excellent expedient has been thought of, and that is the eclipses of Jupiter's satellites.

Now as neither Jupiter nor any of his attendants have any native light of their own, but shine with a borrowed light from the sun, it happens that each of these, in every revolution about Jupiter, suffers two eclipses, one at their entrance into the shadow, the other at the entrance of their passage behind his body; whence in each revolution of the satellite there are four remarkable appearances, by the observation of any one of which the business may be done, *viz.* one at the entrance into the shadow, and one at the emersion out of it; one at the entrance behind the body, and another at the coming out; but the latter of these, *viz.* the ingress and egress of the satellite, into and from under the body, is not so much regarded by astronomers as the immersion into and out of the shadow, because, in the former, the difficulty of pronouncing the exact time is very great, it requiring, in each observer, eyes equally good and strong, and telescopes equally large; but the observation of the former of these, *viz.* the emersion into, and emersion out of the shadow, is easy and practicable, because the quick motions of the satellites plunge them so quickly into the shadow of Jupiter, that it is no difficult matter to pronounce, by any telescope by which they may be seen, the exact time of their immersion and emersion, as any one may soon be satisfied, if he will but try the experiment.

And as each of these happens at the same moment of absolute time, if two or more persons, in different places, note the time of observation, these, when compared together, will give the difference of longitude between the two places of observation. And when we consider the great number of these eclipses that happen every year, there being more visible in one year than there are days in it, and consequently, but few nights when Jupiter may be seen, (and which is near eleven months of the year,) but that an eclipse of one or other happens, and sometimes two or three in a night; the ease with which they may be made, requiring only a telescope of eight or ten feet in length, which may be almost managed with the hand; and the little likelihood there is of missing the times of ingress or egress, they being in a manner momentaneous; and, lastly, the great exactness to which they would give the difference of longitude, it being certainly as exact as the latitude can at present be taken; it is much to be wondered at, that the more skilful part of our seamen have so long neglected them, and especially in the several ports into which they sail. The eclipses of Jupiter's satellites, and their configurations, are given in the nautical ephemeris.

Besides these, there is another method equally useful, expeditious, and certain; and that is, the appulses of the moon to certain fixed stars, and their occultations by the interposition of her body; for, the moon finishing her revolution in the space of twenty-seven days, seven hours, forty-three minutes, there are but few clear nights when the moon does not pass over or so near to some fixed star, that her distance from it, or the time of her visible conjunction with it, may be easily observed by the telescope, and micrometer only; and these, when compared together, or with the visible time computed to the meridian of some place, will show the difference of longitude of those places.

It is a great objection to the methods here described, that the agitation of a ship at sea prevents their being useful. But the invention of Hadley's quadrant and its modern improvements, with the degree of perfection to which the moon's place can now be had, by computation, added to the great facilities afforded by the nautical almanack and requisite tables, published by the commissioners of longitude, and other works, particularly Mendoza's extensive Tables, patronized by them, have rendered the determination of the longitude at sea a thing of easy and general practice, by observations of the angular distance of the moon from a fixed star. This was first proposed by John Warner, in his Notes to Ptolemy's Geography, in 1514, and since by others, particularly our Sir Jonas Moor, Flamstead, Halley, Bradley; and in later times, with great diligence, zeal, and ability, by the present Astronomer Royal, Dr. Maskelyne. For the processes and computations, the reader will have recourse to the works just mentioned. The principle is simple and easy. An observer at sea measures the angle between the moon and the sun, or a fixed star, while two other observers take their altitudes, in order to determine the quantities of refraction and parallax. The two zenith distances, and the oblique distance, constitute a spherical triangle; of which the angle of the zenith may be determined,

and then by correcting the altitudes for parallax and refraction, two other zenith distances may be had, which are correct, and with these and the angle at the zenith, a new triangle is constituted, of which the oblique side is the correct distance. By comparing this distance with those in the nautical almanack, the time at Greenwich is obtained, and the difference between this and the time (observed by an altitude or otherwise) at the ship, gives the difference of longitude. Though this computation with tables, which give every tenth second, is not operose, it is much abridged by the formulæ given in the said works.

Time-pieces are likewise rendered so perfect at present, that they afford the most inestimable assistance to mariners. See Chronometer and Horology. Our John Harrison, between the years 1726 and 1762, first vanquished the great difficulty, and was rewarded with 20,000*l.* from the English government. Very liberal encouragement has since been given to other artists, such as Arnold, Earnshaw, and others.

Longitude *of motion*, according to some philosophers, is the distance which the centre of any moving body runs through, as it moves on in a right line.

LONGITUDINAL, in general, denotes something placed lengthwise: thus some of the fibres of the vessels in the human body are placed logitudinally, others transversely, or across.

LONGOMONTANUS (Christian), a learned astronomer, born in Denmark in 1562, in the village of Longomontam, whence he took his name. Vossius, by mistake, calls him Christopher. Being the son of a poor man, a ploughman, he was obliged to suffer, during his studies, all the hardships to which he could be exposed, dividing his time, like the philosopher Cleanthes, between the cultivation of the earth, and the lessons he received from the minister of the place. At length, at fifteen years old, he stole away from his family, and went to Wiburg, where there was a college, in which he spent eleven years; and though he was obliged to earn his livelihood as he could, his close application to study enabled him to make a great progress in learning, particularly in the mathematical sciences.

From hence he went to Copenhagen; where the professors of that University soon conceived a very high opinion of him, and recommended him to the celebrated Tycho Brahe; with whom Longomontanus lived eight years, and was of great service to him in his observations and calculations. At length, being very desirous of obtaining a professor's chair in Denmark, Tycho Brahe consented with some difficulty to his leaving him; giving him a discharge filled with the highest testimonies of his esteem, and furnishing him with money for the expense of his long journey from Germany, whither Tycho had retired.

He accordingly obtained a professorship of mathematics in the University of Copenhagen, in 1605; the duty of which he discharged very worthily till his death, which happened in 1647, at eighty-five years of age.

Longomontanus was author of several works, which show great talents in mathematics and astronomy. The most distinguished of them is his "Astronomica Danica," first printed in quarto, 1621, and afterwards in folio, in 1640, with augmentations. He amused himself with endeavouring to square the circle, and pretended that he had made the discovery of it; but our countryman, Dr. John Pell, attacked him warmly on the subject, and proved that he was mistaken. It is remarkable, that, obscure as his village and father were, he contrived to dignify and eternize them both; for he took his name from his village, and in the title-page to some of his works, he wrote himself Christianus Longomontanus Severini filius; his father's name being Severin or Severinus.

LONICERA, in botany, *honeysuckle*, named from A. Lonicer, a genus of the Pentandria Monogynia class and order. Natural order of Aggregatæ. Caprifolia, Jussieu. Essential character: corolla one-petalled, irregular; berry many-seeded, two-celled, inferior. There are nineteen species, of which L. grata, ever-green honeysuckle, is the most beautiful: it grows naturally in North America: it has strong branches, covered with a purple bark, which are ornamented with lucid green leaves, embracing the stalks, and continuing their verdure all the year; the flowers are produced in whorled bunches at the end of the branches; there are frequently two, and sometimes three, of these bunches rising one out of the other; they are of a bright red on their outside, and yellow within, of a strong aromatic flavour; it begins to flower in June, and there is a constant succession of flowers till the frost puts an end to them.

LOO, or *lanter-loo*, a game at cards. See Lanter-loo.

LOOF, in the sea-language, is a term

used in various senses; thus the loof of a ship is that part of her aloft which lies just before the chest-tree; hence the guns which lie there are called loof-pieces: keep your loof, signifies keep the ship near to the wind; to loof into a harbour, is to sail into it close by the wind; loof up, is to keep nearer the wind; to spring the loof, is when a ship that was going large before the wind is brought close by the wind.

LOOKING-*glasses*, are nothing but plane mirrors of glass; which being impervious to the light, reflect the images of things placed before them. See OPTICS.

LOOM, a frame composed of a variety of parts, used in all the branches of weaving; for a particular description of which see WEAVING.

LOOM, in the sea-language: when a ship appears big, when seen at a distance, they say she looms.

LOOM *gale*, a gentle easy gale of wind, in which a ship can carry her top-sails a-trip.

LOOP, in the iron works, denotes a part of a sow, or block of cast iron, broken or melted off from the rest.

LOOP *holes*, in a ship, are holes made in the coamings of the hatches of a ship, and in their bulk-heads, to fire muskets through, in a close fight.

LOPHIUS, the *angler*, in natural history, a genus of fishes of the order Cartilaginei. Generic character: head depressed; teeth numerous and sharp; mouth armed with teeth; pectoral fins brachiated. There are eight species, of which we shall notice the following. L. europæus, or the European angler, is a native of the European seas, and measures sometimes seven feet in length, but is generally about three, in shape similar to a tadpole. It frequents the shallow parts of the sea, and imbedding itself almost completely in sand or gravel, moves its tentacula, or the long processes on its head, in various directions. The small fishes, mistaking these for worms, catch at them with avidity, and in the moment of expected happiness find certain destruction. L. histrio, or the harlequin angler, is a native of the Indian and American seas, and is one of the most curious and remarkable of fishes; but we have not here room for the detail of its form and appendages. Its general length is about a foot. Its ventral fins resemble short arms, and Shaw mentions Renard's stating, that he knew an instance of some of these fishes living without water for three days, and walking about the house in the manner of a dog! For a representation of this fish, see Pisces, Plate V. fig. 3.

LOPPING, among gardeners, the cutting off the side-branches of trees.

LORANTHUS, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Aggregatæ. Caprifolia, Jussieu. Essential character: germ inferior; calyx none; corolla six-cleft, revolute; stamens at the tips of the petals; berry one-seeded. There are eighteen species; these are mostly parasitical shrubs, having thick opposite leaves, and axillary flowers: natives of warm climates.

LORD'S *day*. All persons not having a reasonable excuse, shall resort to their parish church or chapel (or some congregation of religious worship allowed by the toleration act) on every Sunday, on pain of punishment by the censures of the church, and of forfeiting one shilling to the poor for every offence. To be levied by the church-wardens by distress, by warrant of one justice. The hundred shall not be answerable for any robbery committed on the Lord's day. No person upon the Lord's day shall serve or execute any writ, process, warrant, order, judgment, or decree (except in cases of treason, felony, or breach of the peace), but the service thereof shall be void. Public houses are shut during the usual hours of divine service.

LORICARIA, in natural history, a genus of fishes of the order Abdominales. Generic character: head smooth; mouth without teeth; gill membrane six-rayed; body mailed. Of this genus there are, according to Gmelin, two species. Shaw enumerates seven. The L. costata is found both in the seas of India and America, and is a fish highly daring, and, by the strength and acuteness of its spines, capable of wounding and lacerating those who attempt to take it with great severity. By the fishermen in those seas they are regarded as formidable enemies. See Pisces, Plate V. fig. 4. L. callicthys, which alone we shall add to the former, is about twelve inches in length, and by the inhabitants of Surinam is regarded as a delicacy. It is stated by a writer of most ludicrous or contemptible credulity, that this fish being harassed occasionally by the shallowness of the stream which it has inhabited, makes an excursion by land in search of another that it may find deeper, or even perforates the land for the same purpose.

LOTION, in medicine and pharmacy, is such washing as concerns beautify-

ing the skin, by cleansing it of those deformities which a distempered blood sometimes throws upon it, or rather are made by a preternatural secretion. There is reason to believe, that almost all the lotions advertised for sale as quack medicines, contain much deleterious matter, such as muriated mercury, and therefore ought never to be had recourse to.

LOTTERY, a game of hazard, in which small sums are adventured for the chance of obtaining a larger value, either in money or other articles. Lotteries are formed on various plans; but in general they consist of a certain number of tickets, which are drawn at the same time, with a corresponding number of blanks and prizes mixed together, and by which the fate of the tickets is determined. This species of gaming has been sanctioned by the governments of France, Holland, Great Britain, and other countries, as a means of raising money for public purposes; as, from the contributions being voluntary, it is always easier to obtain money in this way than by new taxes: it is, however, liable to the serious objection, that it tempts many persons to lose more than they can conveniently spare, particularly among the lower classes of society, who are led to neglect the gains of honest industry for the chance of acquiring sudden riches by a prize in the lottery.

The proposals for the first public lottery in England were published in 1567 and 1568, and it was drawn in 1569, at the west door of St. Paul's cathedral. The tickets were sold at ten shillings each, and there were no blanks. The prizes consisted chiefly of plate; and the profits of it were intended for the repair of the havens of the kingdom, and other public works. In 1612, King James granted permission for a lottery, to be held at the west end of St. Paul's, of which the highest prize was of the value of four thousand crowns, in plate: this was for the assistance of the Virginia company, who were licensed to open lotteries in any part of England, by which means they raised 29,000*l.* At length these lotteries came to be considered a public evil; they attracted the attention of parliament, were represented by the commons as a grievance, and in 1620 were suspended by an order of council. In 1630, however, Charles I. granted a special licence for a lottery, or lotteries, "according to the course of other lotteries heretofore used or practised," for defraying the expenses of a project for conveying water to London.

Soon after the revolution lotteries were resorted to, among other expedients, for raising part of the extraordinary sums necessary for the public service, by which the disposition for this species of gambling was greatly encouraged and extended; and private lotteries, formed on the most delusive and fraudulent principles, became so general, not only in London, but in all the other principal towns of England, that parliament found it necessary, in 1698, to pass an act for suppressing them; by which a penalty of 500*l.* was laid on the proprietors of any such lotteries, and of 20*l.* on every adventurer in them; notwithstanding which, the disposition to fraud on the one hand, and for adventure on the other, continued to prevail, and small lotteries were carried on under the denomination of sales of gloves, fans, cards, plate, and other articles. This was attempted to be checked by a clause of an act passed in 1712, which only gave rise to a new mode of carrying on this kind of gaming. The adventure was now made to depend on the drawing of the government lottery; and the selling and buying of chances and parts of chances of tickets in the state lotteries became a general practice, till it was prohibited by an act passed in 1718, by which all undertakings resembling lotteries, or being dependent on the state lottery, were strictly prohibited, under the penalty of 100*l.* over and above all penalties enjoined by former acts of parliament against private lotteries.

During the reign of Queen Anne, the lotteries were generally for terminable annuities, to which both blanks and prizes were entitled, at different rates: thus, in 1710, the lottery consisted of 150,000 tickets, valued at 10*l.* each; every ticket being entitled to an annuity for thirty-two years, the blanks at 14*s.* per annum, and the prizes to greater annuities, from 5*l.* to 1,000*l.* per annum. This was the first lottery for which the Bank of England received the subscriptions for government. In the following year, the whole of the money advanced for the tickets was to be repaid, both in blanks and prizes, in thirty-two years, with interest at 6 per cent. and an additional sum of nearly half a million to be divided in order to form the prizes; which additional capital was to be paid, with the like interest, within the same period as the original sum. In this manner, which was continued in several of the subsequent

years, a very considerable premium was given for the money advanced, in addition to a high rate of interest.

According to the lottery plans which prevailed from Sir Robert Walpole's administration to that of the Duke of Grafton, the tickets were issued at 10*l.* each; and occasionally the subscription was open to the public at large. The highest prize was generally 10,000*l*, and the lowest 20*l*. There were from four to six blanks to one prize, and the blanks entitled the bearers to five or six pounds stock in 3 or 4 per cent. bank annuities, the value of the blanks and prizes being generally funded. The office-keepers divided the tickets into shares and chances; the former entitling the holders to the proportion they had purchased of blanks and prizes; the chances to prizes only; that is, they had no return if the ticket was drawn a blank. The tickets, according to the advantage or disadvantage of the scheme, in respect to the number of blanks to a prize, and the number of high prizes, generally sold at from 11*l.* to 12*l.* before the drawing. When the ticket sold for 11*l.* and the blank was entitled to 6*l.* in the 3 per cent. annuities, as the blank might be sold for 5*l.* 8*s.* ready money, when the 3 per cents. were at 90, the adventurer only gambled at the risk of 5*l.* 12*s.*; and at the highest calculation, when tickets were worth 13*l.* he never staked more than 7*l.* 12*s.* for a ticket before the drawing.

In 1759, the scheme of the lottery included two prizes of 20,000*l.* each, which had not been the case in any lottery since the reign of Queen Anne. The scheme for the year 1767 contained one prize of 20,000*l.* and this was for many years after the usual amount of the highest prize. About this time a material alteration was made in the plan of the lotteries; the allowance to blanks was discontinued, the whole sum being divided into prizes the number of which was of course considerably increased, particularly as the proportion of small prizes was much greater than it has since been, and in several of the following years was less than two blanks to a prize. All the lotteries during the time Lord North was Chancellor of the Exchequer were formed on this principle, with some variations in the schemes, which favoured the holders of tickets and the lottery-office keepers, and greatly expanded the spirit of gaming: such as paying the prizes in money instead of stock, and making the first drawn ticket for several successive days a capital prize of 1000*l.* or more, which enhanced the price of tickets, and encouraged persons who had blanks drawn to buy in again. Some judicious regulations were, however, adopted, for the security of persons purchasing shares of tickets, by confining the shares into which tickets may be divided into halves, quarters, eighths, and sixteenths, and obliging all lottery-office keepers to deposit the tickets they divide into shares in the bank, and to have the said shares examined and stamped. The practice of insuring tickets and shares was likewise restrained, by enacting that "No person shall sell the chance or chances of any ticket, or any share, for any time less than the whole time of drawing from the day of sale; nor shall receive any sum of money whatsoever, in consideration for the repayment of any sum, in case any ticket shall prove fortunate, or in any case of any chance or event relating to the drawing, either as to time, or its being fortunate; nor shall publish proposals for the same; under the penalty of 500*l.* one half to be paid to the person suing for the same, and the other moiety to his Majesty."

During Mr. Pitt's administration, the lotteries were contracted for entirely distinct from the loans of the respective years; and as it became necessary to endeavour to augment every source of revenue as much as possible, various alterations were made in the lottery schemes, chiefly with the view of raising the price of tickets, and of keeping up the price during the time of drawing. The number and amount of the highest prizes were increased, some of the schemes containing four prizes of 20,000*l.* and others two of 30,000*l.*; while, for the purpose of disposing of a greater number of tickets in the course of the year, the lottery was divided into two or three smaller ones, drawn at different times. The amount of the principal prizes was afterwards still further augmented; the lottery drawn in October, 1807, containing a prize of 40,000*l.* and that drawn in June 1808, six prizes of 20,000*l.*

Notwithstanding the temptations which these schemes held out to the inconsiderate, the contractors found, either from the greater frequency of lotteries, or the increased number of tickets, that it became impossible to get the tickets off their hands, without resorting to a variety of expedients for attracting the public attention, which were carried so far as to become a public nuisance and disgrace. In 1808, a Committee of the House of Commons was appointed, to inquire how far the evils attending lotteries have been remedied by the laws passed respecting the same; who in their report were of

opinion, That (in case it shall be thought expedient to continue state lotteries) the number thereof in each year should be limited to two lotteries, of not more than 30,000 tickets each; that the number of days allowed for drawing, instead of ten, should be brought back to eight for each lottery, the number fixed in 1802; that the number of tickets to be drawn each day should be uncertain, and left to the discretion of the commissioners of stamp duties, and kept secret till the close of the drawing each day, care being taken, as the lottery proceeds, not to leave too great a number undrawn on the latter days of drawing, but that one moiety or upwards be drawn on the four first days thereof; that every lottery-office keeper should, in addition to his own licence, take out a limited number of licences for his agents; and that the limitation of hours during which lottery-offices may be open for the transaction of business, *viz.* from eight o'clock in the morning till eight o'clock in the evening, enacted by 22 George III. c. 47, and renewed in the lottery acts of 1802, and the three following years, but omitted in those of 1806 and 1807, ought in future to be re-enacted, without the exception therein made to Staurday evening.

Lotteries are declared to be public nuisances, 5 George I. c. 9; but for the public service of the government, lotteries are frequently established by particular statutes, and managed by special officers and persons appointed.

By statute 42 George III. c. 54, lottery-office keepers are to pay fifty pounds for every licence in London, Edinburgh, and Dublin, or within twenty miles of either, and ten pounds for every licence for every other office; and licensed persons shall deposit thirty tickets with the Receiver-General of the Stamp Duties, or licence to be void.

By statute 22 Geo. III. c. 47, lottery-office keepers must take out a licence, and offices are to be open only from eight in the morning to eight in the evening, except the Saturday evening preceding the drawing. The sale of chances and shares of tickets, by persons not being proprietors thereof, are prohibited under penalty of fifty pounds, and, by 42 Geo. III. c. 119, all games or lotteries, called Little Goes, are declared public nuisances, and all persons keeping any office or place for any game or lottery, not authorised by law, shall forfeit five hundred pounds, and be deemed rogues and vagabonds. The proprietor of a whole ticket may nevertheless insure it, for its value only, with any licensed office for the whole time of drawing, from the time of insurance, under a *bona fide* agreement without a stamp.

LOTUS, in botany, *bird's foot trefoil*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx tubular: wings converging longitudinally upwards; legume cylindric, straight. There are twenty-three species; these are mostly herbaceous plants, having ternate leaves, petioled with sessile leaflets and two large stipules, of the same form with the leaflets, but distinct from the petiole: peduncles solitary, axillary, and terminating; corollas chiefly yellow.

LOUICHEA, in botany, a genus of the Monadelphia Tetrandria class and order. Essential character: receptacle common peduncle-shaped, trichotomous, producing the flowers; pericarpium proper, four-parted; segments concave, subulate acuminate, irregular growing together; corolla none; filaments four, connate, inserted into the receptacle; germ superior; style bifid; seed single, arilled, within the calyx. There is but one species, *viz.* L. cervina.

LOXIA, the *grosbeak*, in natural history, a genus of birds of the order Passeres. Generic character: bill strong, thick, convex both above and below, and rounded at the base; nostrils small and round at the base of the bill; tongue truncated. These birds are timid and solitary, not distinguished by the beauty of their colours or the sweetness of their notes; and in this country also they are migratory, withdrawing to other lands to breed and rear their offspring. Latham enumerates eighty-four species, and Gmelin no fewer than a hundred; of which we shall notice the following. L. curverostra, or the cross-bill, is about the size of a lark, and the mandibles of its bill curve in opposite directions, and cross each other at the points; and in some individuals the upper mandible crosses to the left, and in others to the right. It is found in many countries to the north of Great Britain, and breeds and remains in them for the whole year: but in some years migrates in considerable flocks. Its favourite food consists of the seeds of pines, and pine woods are always its principal haunts. It holds the cone in one of its claws, like the parrot, and has the manners of that bird in several other respects. In North America, a species builds on the highest firs,

and attaches its nest to the trunk by means of the exuded resin. See Aves, Pl. VIII. fig. 5. L. pyrrhula, or the bullfinch, is commonly known in England, building in bushes of five or six feet high; changing its residence according to the season; in summer retreating from the habitations of man, in winter preferring orchards and gardens, in which it does great mischief by destroying the buds of trees. These birds may be instructed to whistle a variety of tunes, and to utter several words, and two bullfinches have been actually taught to sing in parts; but the natural notes of these birds are monotonous and uninteresting. See Aves, Plate VIII. fig. 7. L. chloris, or the greenfinch, is abundant also in England, where, like the former, it continues throughout the year, but changes its habitation agreeably to the seasons. The female constructs a nest with considerable attention to the warmth and comfort of her young, which she provides for with the fondest assiduity and attachment. The male divides the labours of incubation with his partner. They are familiarised with extreme ease, and will imitate the notes of other birds with great success.

LUCANUS, in natural history, a genus of insects of the order Coleoptera. Antennæ clavate, the club compressed and divided into pectinate leaves; jaws projecting beyond the head, so as to resemble horns, toothed; two palpigerous tufts under the lip. There are about twenty-six species. The principal is the L. cervus, commonly known by the name of stag-beetle, or stag-chaffer. See Plate III. Entomology, fig. 3. This is the largest of all the European coleopterous insects, being between two or three inches long. It is generally of a deep chesnut colour, with some of its parts of a blacker cast. It is chiefly found in the neighbourhood of oak trees, delighting in the honey-dew, so frequently observed on the leaves. Its larva is found in the hollows of oak-trees, residing in the fine vegetable mould usually seen in such cavities, and feeding on the softer parts of the decayed wood. It is large, and of a whitish colour, and when stretched at its length, measures nearly four inches. When arrived at its full size, which is about the fifth or sixth year, it forms a hollow in the earth in which it lies, and afterwards remaining perfectly still for the space of a month, divests itself of its skin, and commences pupa. It is now shorter than before, of a deeper colour, and exhibits in a striking manner the rudiments of the large extended jaws and broad head, so conspicuous in the perfect insect. The chrysalis lies about three months before it gives birth to the complete insect, which usually emerges in the months of July and August. Several species of this genus are natives of America; but a very elegant species has been discovered in New Holland, which differs from the rest in being entirely of a beautiful golden-green colour, with short, sharp-pointed, denticulated jaws, of a brilliant copper-colour.

LUCERNARIA, in natural history, a genus of the Vermes Mollusca class and order; body gelatinous, wrinkled, branched; mouth placed beneath. There are three species, viz. L. quadricornus; body long-coiled, with four forked arms tentaculate at the tip. It inhabits the northern seas, on fuci; feeds on polypi. L. phrygia; body long, papillous, with numerous globiferous arms deflected into a hemisphere; fixed at the base by a byssus or mass of filaments. It inhabits deeps in the Greenland seas, and seldom changes its abode. L. auricula resembles flask; neck round, the lower extremities dilated and surrounded with eight fasciculi of tentaculi. Found in the Greenland seas, adhering very firmly to the largest ulvæ, from which it rarely moves; feeds on onisci, and is about one inch and a half long.

LUCERNE is a plant frequently cultivated in the manner of clover. Its leaves, like the latter, grow three at a joint, its stalks are erect, and, after mowing, immediately spring up again from the stubble. It is made into hay, in the same manner as saintfoin, but should be mowed before it flowers. It makes the sweetest and most fattening food in the world for cattle.

LUDWIGIA, in botany, so named in honour of Christian Gottlieb Ludwig, Professor of Medicine at Leipsic; a genus of the Tetrandria Monogynia class and order. Natural order of Calycanthemæ. Onagræ, Jussieu. Essential character: calyx four-parted, superior; corolla four-petalled; capsule inferior, four cornered, four-celled; receptacle distinct from the axis of the fruit, bearing the seeds on each side. There are four species, natives of the East and West Indies.

LUES, among physicians, is, in general, used for a disease of any kind; but, in a more particular sense, is restrained to contagious and pestilential diseases, as the lues venerea.

LUMBAGO, in medicine, a rheumatic affection of the muscles about the loins.

LUMBRICUS, in natural history, the earth-worm, a genus of the Vermes Intestina: body round, annulate, with generally an elevated fleshy belt near the head, mostly rough, with minute concealed prickles, placed longitudinally, and furnished with a lateral aperture. Gmelin has enumerated sixteen species, of which we shall notice the following: L. terristris, dew-worm; body red, with eight rows of prickles; there are two varieties, one being as long again as the other. It inhabits decayed wood, and the common soil, which, by perforating, it renders fit to receive rain; devours the cotyledons of young plants, and wanders about in the night; is the food of moles, and various birds. It is said to have about one hundred and forty rings; head taper; mouth at the end, round; fore-part of the worm cylindric, the rest depressed; at about one third of its length is a prominent annulated belt; on each side of the belly a row of minute spines, distinguishable only by the touch, but which are of aid to their motion. L. marinus, the lug; back with two rows of bristly tubercles. This species inhabits the shores of the sea, where it buries itself deep in the sand, leaving a little rising with an aperture on the surface, and is used as a bait for fish. Body pale red, round and annulate, with greater and lesser rings; the first prominent, with two opposite tufts of short bristles on each; the lower part smooth. L. vermicularis, body white, with two rows of prickles; inhabits the wet and decayed trunks of trees, and among moist leaves, moving very expeditiously in humid places, but twisting itself up in dry ones: body polished, glabrous. L. edulis, body whitish flesh-coloured; subclavate behind, dilated and papillous before; mouth terminal, and surrounded with a very villose rim or wrinkle. It inhabits the sandy shores of the islands in the Indian ocean; nearly a foot long, and about as thick as a goose quill; buries itself about a foot or more deep in the sand, and is eaten by the Chinese: the rings between the villous part and the hinder end 278, and separated by an annular stria; the hind part bulbous, with a double papilla; the fore-part beset with numerous flesh-coloured ones, disposed in transverse rows.

LUNA, in astronomy, the moon. See MOON.

LUNA, among chemists, signifies silver. See SILVER.

LUNAR, something belonging to the moon; thus we say lunar month, lunar year, lunar dial, lunar eclipse, &c.

LUNAR *caustic*, is the old name for nitrate of silver, a very powerful caustic, much used in medicine. It is also called "Lapis Infernalis," by surgeons.

LUNARIA, in botany, *honesty*, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ or Cruciformes. Essential character: silicle entire, elliptic, compressed, flat, pedicelled; valves equal, and parallel to the partition, flat; calyx with bagged leaflets. There are three species, *viz.* the perennial, annual, and Egyptian honesty.

LUNATIC. See IDIOT.

LUNATION, the period or time between one new moon and another: it is also called the synodical month, consisting of $29^d\ 12^h\ 44'\ 3''\ 11\text{-}3$ds; exceeding the periodical month by $2^d\ 5^h\ 0'\ 55''$.

LUNE, in mathematics, is a geometrical figure, in form of a crescent, terminated by the arcs of two circles that intersect each other within. Though the quadrature of the whole circle has never been effected, yet many of its parts have been squared. The first of these partial quadratures was that of the lunula, given by Hippocrates, of Scio, or Chios; who, from being a shipwrecked merchant, commenced geometrician. But although the quadrature of the lune be generally ascribed to Hippocrates, yet Proclus expressly says, it was found out by Oenopidas of the same place. The lune of Hippocrates is this: let A B C, Plate IX. Miscel. fig. 7, be a semi-circle, having its centre E; and A D C a quadrant, having its centre F; then the figure A B C D A, contained between the arcs of the semicircle and quadrant, is his lune; and it is equal to the right-angled triangle A C F, as is thus easily proved. Since $AF^2 = 2AE^2$, that is, the square of the radius of the quadrant equal to double the square of the radius of the semi-circle; therefore the quadrant-area, A D C F A, is = the semi-circle of A B C E A; from each of these take away the common space A D C E A, and there remains the triangle A C F = the lune A B C D A. Another property of this lune, which is the more general one of the former, is, that if F G be any line drawn from the point F, and A H perpendicular to it; then is the intercepted part of the lune A G I A = the triangle A G H, cut off by

the chord line A G; or, in general, that the small segment, A K G A, is equal to the tri-lineal A I H A. For, the angle A F G being at the centre of the one circle, and at the circumference of the other, the arcs cut off A G, A I are similar to the wholes A B C, A D C, therefore the small segment A K G A is to the semi-segment A I H, as the whole semi-circle A B C A to the semi-segment or quadrant A D C F, that is, in a ratio of equality. Again, if A B C (fig. 8) be a triangle, right-angled at C, and if semi-circles be described on the three sides as diameters; then the triangle T (A B C) is equal to the sum of the two lunes L 1, L 2. For the greatest semi-circle is equal to the sum of both the other two; from the greatest semi-circle take away the segments S 1, and S 2, and there remains the triangle T; also from the two less semi-circles take away the same two segments S 1 and S 2, and there remains the two lunes L 1, and L 2; therefore the triangle $T = L\,1 + L\,2$, the two lunes.

LUNETTE, in fortification, an enveloped counter-guard, or mound of earth, made beyond the second ditch, opposite to the place of arms; differing from the ravelines only in their situation. Lunettes are usually made in wet ditches, and serve to defend the passage of the ditch.

LUNGS, a part of the human body, which is the cause or instrument of respiration.

LUPINUS, in botany, *lupine*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx two lipped; anthers five oblong, five roundish; legume coriaceous. There are ten species, the most common is the L. luteus, yellow lupine, which is about one foot in height, having digitate leaves, composed of seven, eight, or nine hairy leaflets, nearly two inches long: the flowers are odorous in loose spikes at the end of the branches, composed of several whorls, terminated by three or four flowers, sitting close at the top; these are succeeded by ovate flattish hairy pods, about two inches long, standing erect, inclosing four or five seeds, compressed, of a yellowish white colour, variegated with dark spots: it is a native of Sicily.

LUPULUS, the *hop*, in botany, &c. See Hop and Humulus.

LUPUS. See Canis.

Lupus, in ornithology, the same with the monedula, or jackdaw. See Jackdaw.

Lupus *marinus*, the *sea-wolf*, in ichthyology, formerly constituted a genus of malacopterygious fishes, with a compressed body, and six or more ossicles in the membrane of the gills. On the back there is only one fin, which extends almost from the head to the tail. It is a very singular fish, growing to four or five feet long. This fish is now called Anarrhichas, by the generality of authors; which see.

Lupus, in astronomy, a southern constellation, consisting of nineteen, or, according to Flamstead, of twenty-four stars.

LURIDÆ, in botany, the name of the twenty-eighth order in Linnæus's "Fragments of a Natural Method," consisting of plants whose pale and ominous appearance seems to indicate something noxious in their nature and quality: theatropa, deadly night-shade; capsicum, guinea-pepper; digitalis, fox-glove; nicotiania, tobacco, &c. are of this order. Most of the plants contained in the order are herbaceous and perennial; the roots are generally branched, sometimes tuberous; the stems and branches are cylindric: the leaves are simple, and placed alternate; the flowers are hermaphrodite; the calyx is one piece deeply divided into five parts; the corolla consists of one petal, which is either bell, funnel, or wheel-shaped; the stamina are four or five; the seed-bud is placed above the receptacle of the flower; the seed vessel is sometimes a berry, sometimes a capsule; the seeds are numerous, and frequently kidney-shaped. These plants have an insipid taste, and a nauseous disagreeable smell; the greater part, taken internally, if in considerable quantity, prove mortal, unless prevented operating by emetics, &c.

LUST, in the sea-language. When a ship heels more one way than another, she is said to have a lust that way.

LUSTRE, in mineralogy, is a term much used in modern works of chemistry. The lustre of minerals in respect of intensity is of five kinds; 1. Splendent, when in full daylight the lustre can be seen at a great distance: 2. Shining, when at a distance the reflected light is weak: 3. Glistening, when the lustre is only observable at no greater distance than an arm's length: 4. Glimmering, when the surface held near the eye in full daylight presents a number of shining points: 5. Dull, when the surface has no lustre. There are two kinds of

lustre, the metallic and common. See Thompson's Chemistry.

LUTE, a musical instrument with strings. The lute consists of four parts, *viz.* the table; the body or belly, which has nine or ten sides; the neck, which has nine or ten stops or divisions, marked with strings; and the head, or cross, where the screw for raising and lowering the strings to a proper pitch of tone are fixed. In the middle of the table there is a rose or passage for the sound; there is also a bridge that the strings are fastened to, and a piece of ivory, between the head and the neck, to which the other extremities of the strings are fitted. In playing, the strings are struck with the right hand, and with the left the stops are pressed. The lutes of Bologna are esteemed the best, on account of the wood, which is said to have an uncommon disposition for producing a sweet sound.

LUTES. See LABORATORY.

LUTHERANS, so called from their founder, Martin Luther, an Augustine friar, and one of the earliest of the reformers. Some of the doctrines of the Lutherans, as they were originally taught by their founder, seem to have differed in but a very slight degree from those of the church of Rome, from whom Luther dissented. For that reformer held sacred, or at least connived at, many things which Calvin, Zuinglius, and the rest of the reformers, abhorred as so many of the gaudy vestments and abominations of the Whore of Babylon. Concerning transubstantiation, Luther seems to have differed more in word than in substance from the Church of Rome. He held that the body and blood of Christ were materially present in the Eucharist, though he professed his ignorance of the manner in which that presence was accomplished. It is true, he laid aside the offensive term transubstantiation, and substituted that of consubstantiation in the room of it; but whether the bread and wine are, as the Catholics declare, transubstantiated into the real body and blood of Christ, or whether, as Luther asserted, the material elements are mystically consubstantiated with the body and blood of the Saviour, by the consecration of the priest, it is clear the Catholics and the Lutherans both held the doctrine of the real presence.

Luther also tolerated the use of images, altars, wax tapers, the form of exorcism, and private confession. But the grand and leading doctrine of Lutheranism, and that on which the permanent foundation of the reformation was laid, is the right of private judgment in matters of religion. "To the defence of this proposition," says Mr. Roscoe, the candid and elegant biographer of Leo the Tenth, "Luther was at all times ready to devote his learning, his talents, his repose, his character, and his life; and the great and imperishable merit of this reformer consists in his having demonstrated it by such arguments, as neither the efforts of his adversaries, nor his own subsequent conduct, have been able either to confute or invalidate."

No sooner, however, had Luther succeeded in effecting a separation from the Church of Rome, than he set himself to establish another system of religious government; in which he manifested, that, however he might abominate many of the doctrines and practices of the Papal government, he still retained no small portion of that spirit of domination by which the old church had so long been characterized. The *odium theologicum* threatened to receive new strength with the reformation, and, under the auspices of Calvin and Luther, the religious world seemed likely to derive no other benefit from the reformation than that of a change of masters. It was more easy to change the head than the heart; and the language of liberty afforded a ready but a miserable substitute for liberty itself. Nor, indeed, did Luther at all times even make use of such language as might have been expected from one who had so ably maintained that great and leading truth, which inculcates the unfettered rights of private judgment. The man who could stigmatize the learned and mild Erasmus, who had defended the freedom of the human will, as "an exasperated viper;" "a vain-glorious animal," seemed but ill qualified to emancipate the religious world from the fetters of spiritual tyranny. Nor was it very flattering to the reformation, that one of its ablest defenders and founders could, in his zeal for the omnipotence of faith, declare that the Epistle of James, in which the necessity of good works is stated and enforced, is, in comparison with the writings of Peter and Paul, *a mere book of straw!* These were but ill omens of the success of the reformation. Whilst Luther was engaged in his opposition to the Church of Rome, he asserted the right of private judgment in matters of faith, with the confidence and courage of a martyr; but no sooner had he freed himself and his followers from the ecclesiastical tyranny of the

Pope, than he attempted to establish another tyranny equally intolerable; "and it was the employment of his latter years to counteract the effects produced by his former labours. The great example of freedom," continues Mr. Roscoe, "which he had exhibited, could not, however, be so soon forgotten; and many who had thrown off the authority of the Romish see, refused to submit their consciences to the control of a monk, who had arrogated to himself the sole right of expounding those scriptures which he had contended were open to all." The reformation consequently gained ground, in spite of the opposition of both the Church of Rome, and the example of the Lutherans. Aided by the invention of printing, the genuine principles of reason, philosophy, and revelation, began to make rapid progress. The doctrines of justification by faith alone, and of absolute unconditional election and reprobation, could no more prevent the spread of knowledge than the worship of images, or the invocation of saints. Luther had taught the religious world, that the mind of man cannot be subjected to the imperious decrees of fallible councils and human power, and the result was glorious. The human mind, delivered from the external constraint imposed upon it by hierarchical despotisms, and from the internal constraint of the apathy in which it was kept by a blind superstition, soon found itself emancipated from guardianship, and began to make a free, energetic, and proper use of its faculties. The documents of religion were subjected to a profound criticism; and, as the study of the fathers and of councils were connected with the decretals of antiquity, history, and languages, the great objects of classical learning began to assume a new aspect, and to be illuminated by a new light. The scholastic philosophy found in the Lutherans most formidable adversaries, who unveiled its vices, and attacked its weak sides. The torch of reason, which had too long smothered in the recesses of the cloister, and glimmered in the cells of the monks, was no sooner admitted to the re-animating atmosphere of freedom and philosophy, than it began to shine forth in its native lustre. The empty science of the casuists vanished before the morality of the gospel. In short, the human mind, thus liberated from the fetters of priestcraft and tyranny, shook off the corruptions which it had gathered during the middle ages, and without fear of the inquisition here, or the terrors of eternal damnation hereafter, began to display its native activity, to probe the foundations of tottering societies, the rights of mankind, the laws of empires, and the governments of churches. May the happy influence of the reformation, thus brought into action by the fearless, though priestly Luther, continue to spread itself till the whole world is freed from the shackles of superstition, and the glorious empire of truth, reason, and religion, shall be established in every country, and its mild laws be written on every heart!

LUTRA, the *otter*, in natural history, a genus of mammalia of the order Feræ. Generic character: six cutting teeth rather sharp; canine teeth longer; feet webbed. There are eight species, of which we shall notice only the following.

L. vulgaries, is met with in almost all the countries of Europe, and throughout the north of Asia. It is not considered as completely amphibious, but can subsist a long while under water, lives principally upon fish, and takes its prey with great facility in rivers and lakes, in the banks of which it generally fixes its habitation, forming it with extreme elaborateness and precaution with respect to danger. When unable to procure fishes, it destroys and devours the smaller quadrupeds. It is highly fierce, and, when pursued by dogs, will defend itself with uncommon vigour and perseverance, uttering no sounds of pain or fear, though almost torn to pieces by its assailants, but employing its last efforts of existence in inflicting upon them in return the most dreadful wounds and lacerations. The female produces four or five young in the spring. Otters have been so successfully tamed, notwithstanding all their fierceness, as to accompany their owners like dogs, and obey calls and signals with the same promptitude. Mr. Bewick relates, that Mr. James Campbell possessed a young otter of this description, and which had been trained by him with such success to catch fish, that in a single day it would sometimes take ten salmon. When wearied with its hunt, it would decline further exertion, and receive its reward in an ample repast on the fish it had taken, and fall almost instantaneously to sleep, being generally conveyed home in that state. It would fish in the sea as well as in rivers. Otters are sometimes seen in Guinea in large companies, and of immense size, weighing not less than one hundred pounds, and so savage as to be highly dangerous. Otters are remarked for eating only the head and upper parts of the fishes which they take, unless particularly pressed by hunger, and appear to have

a propensity to destruction itself, like the pole-cat, always killing many more animals than it can devour. See Mammalia, Plate XVI. fig. 6.

L. Marina, or the sea-otter, is about four feet and a quarter in its whole length, and is found almost solely between the forty-fourth and sixtieth degree of N. latitude, and the one hundred and twentieth and one hundred and fiftieth degree of E. longitude. Its skin is an important article of commerce between the Russians and the Chinese, and a single fur of this animal is not unfrequently sold for the amazing price of twenty-five pounds. Sea-otters are perfectly inoffensive, and the female manifests the most affectionate attachment to her young, fondling it with endless caresses, and often throwing it in the air and catching it with the utmost caution and tenderness. These animals feed on crabs, lobsters, and other shell-fish, and frequent the shallows which are most thickly covered with sea weeds. The flesh of the young is thought particularly like lamb, and is highly valued. The American species are, the Canadensis, Lutris, Lutra, Lutreola, and Minx.

LUXATION, in surgery, is when any bone is moved out of its place or articulation, so as to impede or destroy its proper motion or office: hence it appears, that luxations are peculiar to such bones as have moveable joints.

LYCHNIS, in botany, a genus of the Decandria Pentagynia class and order. Natural order of Caryophyllei. Essential character: calyx one-leafed, oblong, even; petals five, with claws, and a sub-bifid border; capsule five-celled. There are twelve species.

LYCIUM, in botany, *box-thorn*, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla tubular, closed at the throat by the beard of the filaments; berry two-celled, many-seeded. There are thirteen species. Several of these shrubs, from China and the Cape of Good Hope, will bear the open air in a warm situation and dry soil, when they have once acquired strength, except in very severe winters, especially if the roots are covered with litter, and the branches with mats.

LYCOPERDON, in botany, a genus of the Cryptogamia Fungi class and order. Natural order of Fungi, or Mushrooms. Generic character: fungus roundish, fleshy, firm, becoming powdery, and opening at the top; seeds fixed to filaments connected with the inner coat of the plant. These singular fungi are described by Dr. Withering; there is also an elaborate dissertation on the British stellated lycoperdons, by Mr. Woodward, in the second volume of the Transactions of the Linnean Society of London.

LYCOPODIUM, in botany, *wolf's foot*, or *wolf's claw moss*, a genus of the Cryptogamia Miscellaneæ class and order. Natural order of Musci, or Mosses. Generic character: fructifications in the axils of the scales digested into oblong imbricate spikes, or the leaves themselves, sessile; capsule kidney-shaped, two-valved, elastic, many-seeded; veil none. There are several species; six of these are natives of Britain, figured by Dillenius and others.

LYCOPSIS, in botany, *wild bugloss*, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Essential character: corolla with the tube bent in. Natives of the South of Europe.

LYCOPUS, in botany, *water horehound*, a genus of the Diandria Monogynia class and order. Natural order of Verticellatæ. Labiatæ, Jussieu. Essential character: corolla four-cleft; with one division emarginate; stamina distant; seeds four, retuse. There are three species.

LYDIAN *stone*, in mineralogy, is of a greyish black colour, which passes into velvet black; it occurs massive, and is likewise found in trapezoidal-shaped rolled pieces, with rounded angles; it is hard, but not very heavy. This mineral is found near Prague and Carlsbad, in Bohemia; in other parts of Germany; and in Scotland. When polished, it is used as a test stone for determining the purity of gold and silver; owing, however, to its great hardness, it is less suited for this purpose than basalt. It takes its name from the circumstance of its being first found in the province of Lydia in Lesser Asia.

LYGEUM, in botany, a genus of the Triandria Monogynia class and order. Natural order of Gramineæ, or *Grasses*. Essential character: spathe one-leafed; corolla two on the same germ; nut two-celled. There is only one species, *viz.* L. spartum, rush-leaved lygeum, or hooded matweed, which is a native of Spain, where it is useful for making baskets and ropes, also for filling their paillasses or lower mattresses.

LYING *to*, in naval affairs, the situation of a ship when she is retarded in her course, by arranging the sails in such

a manner as to counteract each other with nearly equal effort, and render the ship almost stationary with respect to her head-way; a ship is usually brought to by laying either her main-top-sail aback, the helm being put close down to leeward. This is particularly practised in a general engagement, when the hostile fleets are drawn up in two lines of battle opposite each other. It is also used to wait for some other ship, either approaching or expected; or to avoid pursuing a dangerous course, especially in foggy weather, &c.

LYMPH, a fine fluid, separated in the body from the mass of blood, and contained in peculiar vessels. It is distinguished into watery and coagulable lymph; the former, as tears, for an example, is little else than water holding in solution a small portion of salt, and still less of animal matter. Coagulable lymph, which is found in the dropsy, contains a very considerable portion of albumen, so as to be viscid to the touch; and when heated to coagulate firmly, like the white of an egg.

LYMPHATICS, or Lympheducts, in anatomy. See preceding article.

LYONS (Israel), a good mathematician and botanist, was the son of a Polish Jew, silversmith, and teacher of Hebrew at Cambridge, in England, where he was come to settle, and where young Lyons was born, 1739. He was a very extraordinary young man for parts and ingenuity; and showed very early in life a great inclination to learning, particularly in mathematics, on which account he was much patronised by Dr. Smith, master of Trinity College. About 1755 he began to study botany, which he continued occasionally till his death; in which he made a considerable progress, and could remember not only the Linnæan names of almost all the English plants, but even the synonyma of the old botanists; and he had prepared large materials for a Flora Cantabrigiensis, describing fully every part of each plant from the specimen, without being obliged to consult, or being liable to be misled, by former authors.

In 1758, he obtained much celebrity, by publishing " A Treatise on Fluxions," dedicated to his patron Dr. Smith; and in 1763, " Fasciculus Plantarum circa Cantabrigiam," &c. In the same year, or the year before, he read lectures on botany at Oxford with great applause, to at least sixty pupils; but he could not be prevailed on to make a long absence from Cambridge.

Mr. Lyons was some time employed as one of the computers of the nautical almanac; and besides he received frequent other presents from the Board of Longitude for his own inventions. He had studied the English history, and could quote whole passages from the monkish writers verbatim. He could read Latin and French with ease, but wrote the former ill. He was appointed by the Board of Longitude to sail with Captain Phipps, in his voyage towards the north pole, in 1773, as astronomical observator; and he discharged that office to the satisfaction of his employers. After his return from this voyage he married, and settled in London, where he died of the measles in about two years.

At the time of his death he was engaged in preparing for the press a complete edition of all the works of the late learned Dr. Halley, a work very much wanted. His calculations in " Spherical Trigonometry abridged," were printed in the Philos. Trans. vol. lxv. for the year 1775, page 470. After his death, his name appeared in the title-page of a Geographical Dictionary, the astronomical parts of which were said to be " taken from the papers of the late Mr. Israel Lyons of Cambridge, author of several valuable mathematical productions, and astronomer in Lord Mulgrave's voyage to the northern hemisphere." The astronomical and other mathematical calculations, printed in the account of Captain Phipps's voyage towards the north pole, mentioned above, were made by Mr. Lyons. This appeared afterwards, by the acknowledgment of Captain Phipps, when Dr. Horsley detected a material error, in some part of them, in his " Remarks on the Observations made in the late Voyage, &c." 1774.

" The Scholar's Instructor, or Hebrew Grammar, by Israel Lyons, teacher of the Hebrew tongue in the university of Cambridge," the 2d edition, &c. 1757, 8vo.; was the production of his father, as was also another treatise, printed at the Cambridge press, under the title of " Observations and Inquiries relating to various parts of Scripture History," 1761.

LYRE, a musical instrument of the string kind, much used by the ancients. From the lyre, which all agree to have been the first instrument of the string kind in Greece, arose an infinite number of others, differing in shape and number of strings, as the psalterion, trigon, sambucus, pectis, magadis, barbiton, testudo, (the two last are used promiscuously by

Horace with cythara and lyra) epigonium, simmicium, and pandoron; which were all struck with the hand, a plectrum or a little iron-rod. We have no satisfactory account of their shape, structure, or number of strings; their bare names only have been transmitted to us by the ancients. We see, indeed, numbers of instruments on old medals; but whether they are any of these, we cannot find out. The modern lyre, or Welsh harp, consisting of forty strings, is sufficiently known. The lyre among poets, painters, statuaries, carvers, &c. is attributed to Apollo and the Muses.

Lyre, in astronomy, a constellation of the northern hemisphere. See Astronomy.

LYRIC, in general, signifies something sung or played on the lyre; but it is more particularly applied to the ancient odes and stanzas, answering to our airs and songs, and may be played on instruments. This species of poetry was originally employed in celebrating the praises of gods and heroes, though it was afterwards introduced into feasts and public diversions. Mr. Barnes shows how unjust it is to exclude heroic subjects from this kind of verse, which is capable of all the elevation such matters require. The characteristic of this kind of poetry is, according to Trap, the sweetness and variety of the verse, the delicacy of the words and thoughts, the agreeableness of the numbers, and the description of things most pleasing in their own natures. At first the lyric verse was only of one kind, but afterwards they so continued to vary the feet and numbers, that the variety of them now are almost innumerable.

This kind of poem is distinguished from all other odes, by the happy transitions and digressions which it beautifully admits, and the surprising and natural easy returns to the subject, which is not to be obtained without great judgment and genius.

The lyric is, of all kinds of poetry, the most poetical, and is as distinct, both in style and thought, from the rest, as poetry is in general from prose: it is the boldest of all other kinds, full of rapture, and elevated from common language the most that is possible: some odes there are likewise, in the free and loose manner, which seem to avoid all method, and yet are conducted by a very clear one, which affects transitions seemingly without art, but for that reason have the more of it; which are above connection, and delight in exclamations and frequent invocations of the muses, which begin and end abruptly, and are carried on through a variety of matter with a sort of divine pathos, above rules and laws, and without regard to the common forms of grammar. Pindar has set his successors the example of digressions and excursions. To write a lyric poem are required, not only a flowing imagination, brightness, life, sublimity, and elegance, but the nicest art and finest judgment, so as to seem luxuriant, and not be so; and under the show of transgressing all laws, to preserve them.

LYSIMACHIA, in botany, *loosestrife*, a genus of the Pentandria Monogynia class and order. Natural order of Rotaceæ. Lysimachiæ, Jussieu. Essential character: corolla wheel-shaped; capsule globular, mucronate, ten-valved. There are twelve species; most of these have perennial roots, herbaceous stems, and the leaves opposite; flowers axillary, or terminating solitary, or else in spikes or corymbs.

LYTHRUM, in botany, *willow-herb*, a genus of the Dodecandria Monogynia class and order. Natural order of Calycanthemæ. Salicariæ, Jussieu. Essential character: calyx twelve-toothed; petals six, inserted into the calyx: capsule two-celled, many-seeded. There are eighteen species.

LYTTA, in natural history, a genus of insects of the order Coleoptera. Antennæ filiform; four feelers, unequal, the hind ones clavate; thorax roundish; head inflected, gibbous; shells soft, flexile, as long as the abdomen. There are upwards of thirty species, many of which are equal in virtue to the L. vesicatoria or blistering fly, (Cantharides of the shops.)

M.

M, Or m, the twelfth letter and ninth consonant of our alphabet: it is a liquid and labial consonant, pronounced by striking or moving the under lip against the upper one: its sound is always the same in English, and it admits no consonant after it in the beginning of words and syllables, except in some Greek words, nor does it come after any in that case. It suffers not the sound of *n*, coming after it, to be heard, as in autumn, solemn, &c.

As a numeral, M stands for mille, a thousand; and with a dash over it thus, $\overline{M}$, for a thousand times a thousand, or, 1,000,000. M. A. magister artium; M. D. medicinæ doctor; MS. manuscript; and MSS. manuscripts, in the plural. In the prescription of physicians, M. stands for manipulus, a handful; and sometimes for misce, or mixtura: thus M. F. Jupalium, signifies mix and make into a julap. In astronomy, &c. M is used for meridian or meridional.

MABA, in botany, a genus of the Dioecia Triandria class and order. Essential character: calyx trifid; male, corolla trifid; female, drupe superior, two-celled. There is but one species, *viz.* M. elliptica. This is a smooth tree, with the twigs and young leaves hairy; leaves alternate, on short petioles, elliptic, and veined; peduncles axillary, short, often three-flowered; flowers small, and remarkable for having the outside of the calyx and corolla more villose than the rest of the plant. There is another species, or variety, which Foster calls maba major; for this reason, the drupe, or fruit, is three times the size of the other, having three-sided kernels in the cells, which are tough and insipid; they are, however, eaten by the inhabitants: in all the Friendly Islands they plant this tree about their houses.

MABEA, in botany, a genus of the Monoecia Polyandria class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: calyx one-leafed, five-toothed; corolla none: male, filaments nine to twelve, inserted into the bottom of the calyx: female, germ and style one; stigma three, revolute; capsule covered with a thick bark, three-celled, three-seeded. There are two species, *viz.* M. piriri, and M. tarquari, both shrubs, yielding a milky juice; the Negroes use the smaller branches for pipes, for which reason the trees are called pipe wood, or *bois a calumet.*

MACAO, or Macaw, in ornithology, a name given to the larger species of parrots with very long tails. See Ptissacus.

MACARONIC, or Macaronian, an appellation given to a burlesque kind of poetry, made up of a jumble of words of different languages, and words of the vulgar tongue latinized.

The Italians are said to have been the inventors of it. The Germans, French, Spaniards, &c. have also had their macaronic poets; nor is Great Britain outdone in this respect, witness Drummond of Hauthornden's poem called Polemo Middinia, which begins thus:

Nymphæ, quæ colitis highissima monta Fifæa,
Seu vos Pittenweema tenet, seu Crelia crofta, &c.

MACE, the second coat or covering of the kernel of the nutmeg, is a thin and membranaceous substance, of an oleaginous nature, and a yellowish colour; being met with in flakes of an inch and more in length, which are divided into a multitude of ramifications. It is of an extremely fragrant, aromatic, and agreeable flavour, and of a pleasant, but acrid and oleaginous taste. See Nutmeg.

MACERATION, in pharmacy, is an infusion of or soaking ingredients in water, or any other fluid, in order either to soften them, or draw out their virtues.

MACHINE, in general, whatever hath force sufficient to raise or stop the motion of a heavy body.

Machines are either simple or compound: the simple ones are the seven mechanical powers, *viz.* lever, balance, pully, axis and wheel, wedge, screw, and inclined plane.

From these the compound ones are formed by various combinations, and serve for different purposes; in all which, the same general laws take place, *viz.* that the power and weight sustain each other, when they are in the inverse proportion of the velocities they would have in the directions wherein they act, if they were put in motion. Now, to apply this law to any compound machine, there are four things to be considered: 1. The moving power, or the force that puts the machine in motion; which may be either men or

other animals, weights, springs, the wind, a stream of water, &c. 2. The velocity of this power, or the space it moves over in a given time. 3. The resistance, or quantity of the weight to be moved. 4. The velocity of this weight, or the space it moves over in the same given time.

The two first of these quantities are always in the reciprocal proportion of the two last: that is, the product of the first two must always be equal to that of the last: hence, three of these quantities being given, it is easy to find the fourth; for example, if the quantity of the power be 4, its velocity 15, and the velocity of the weight 2, then the resistance, or quantity of the weight, will be equal to $\frac{4 \times 15}{2} = \frac{60}{2} = 30$.

Compound machines are extremely numerous, as mills, pumps, wheel-carriages, clocks, fire-engines, &c. See Engine, Mill, Pump, Water-*works*, &c.

Machine denotes any thing that serves to augment or regulate moving powers, or it is a body designed to produce motion, so as to save either time or force. Machines are either simple or compound. The simple machines are the mechanical powers, *viz.* the lever, the wheel and axis, the pulley, the inclined plane, the wedge, and the screw. See Mechanics.

These simple machines serve for different purposes, and it is the business of the skilful mechanician to select and combine them in such a manner, as may be best adapted to produce the effect of which he stands in need. Compound machines are formed from these simple ones. These may be indefinitely varied, and they belong to all the branches of science. Descriptions of many of the most useful, and which serve to exhibit the principles of machinery, will be found in various parts of our work. See Engine, Hydraulics, Pneumatics, &c. &c.

The modes of applying mechanical forces are almost as various as the machines that are constructed, and the purposes for which they are employed. In general the human strength is applied by means of levers, or winches, or by walking wheels, which slide beneath them as they attempt to ascend. The force of other animals is applied by a horizontal arm projecting from a vertical axis, to which they are harnessed. When motion is simply communicated to a substance placed before the moving body, such materials are used as are capable of exerting a repulsive force; but when the body to be moved is behind the moving power, and is pulled along with it, chains or ropes are sometimes more convenient. When the direction of motion communicated is also to be changed, levers or cranks may be employed, united by joints or hinges of various kinds. Sometimes a long series of connected rods is suspended by other rods or chains, so as to convey the effect of the force to a considerable distance; in this case the motion is generally alternate, as when pumps are worked by means of a water-wheel at a distance from the shafts in which the pumps are placed. For the communication of a rotatory motion, Dr. Hooke's universal joint, formed by a cross, making the diameters of two semicircles, one of which is fixed at the end of each axis, is frequently used. The best mode of connecting a rotatory motion with an alternate one is, in all common cases, to employ a crank, acting on one end of a long rod which has a joint at the other. If the rotatory motion of the crank be equable, the progressive motion of the rod will be gradually accelerated and retarded, and for a considerable part of the revolution the force exerted will be nearly uniform. The force applied to a machine may, in general, be divided into two portions, the one employed in opposing another force, so as to produce equilibrium only, the other in generating momentum. With respect to the first portion, a single crank has the inconvenience of changing continually the mechanical advantage of the machinery; with regard to the second, its motion in the second quarter of its revolution is accelerated, instead of being retarded, by the inertiæ which this portion of the force is intended to overcome; hence the motion is irregular. This difficulty may be remedied by employing cranks in pairs, one of which being fixed so as to make a right angle with the other, which is moreover the best position for two winches to be turned by two labourers; since the point of the circle, in which a man can exert his greatest strength, is nearly at the distance of a right angle, or a little more, from the point at which his force is smallest. But of all the modes of communicating motion, the most extensively useful is employment of wheel-work, which is capable of varying its direction and its velocity without any limit. See Wheel-*work*.

Machine, *electric*. The electric machine consists of three parts, the electric body, which is rubbed; the rubber, which

is a compounded conductor; and the prime conductor, which is destined to receive and convey the electricity, in making experiments. The first electrical apparatus consisted of a tube of glass, or a stick of sealing-wax, rubbed by the hand. Glass globes, whirled quickly on an axis, were substituted as an improvement, and the rubber was still the hand: but subsequently a round concave cushion. These were succeeded by glass cylinders, which are cheap, safe, and considerably powerful; but the present fashion determines in favour of flat glass plates, on account of the advantage of a large surface, rubbed by two or more pairs of cushions, and the equality of pressure, which causes the supply of electricity to be steady and without undulation, as to its quantity. Machines of very great power (see "Nicholson's Journal," quarto), have been made by M. Walckiers, consisting of an endless web or jack-towel of silk, passing between two pair of cylindrical rubbers, faced with cat-skin; the electricity being communicated to a prime conductor, lying between the parallel pieces of the silk.

The rubber is usually a piece of wood fitted to the surface intended to be subjected to friction, and covered first with two or three thicknesses of elastic cloth, then with smooth leather, and lastly with a flap of silk, pasted upon the edge at which the glass in its rotation arrives, and passing loose over the face of the cushion, and thence upon the surface of the glass, as far as the commencement of the prime conductor. Its use has been explained under the article Excitation.

In fig 1, Plate Machine Electric, A represents the glass cylinder of a machine, turned by, B, the handle. Its surface rubs against, C, the cushion, which proceed, D, the sill flap, and the electricity is conveyed to E, the prime conductor. The supports of the cylinder, the cushion, and (indispensably) of the prime conductor, are made of glass or baked wood, in order that the electricity may not be conveyed to the earth, unless when the operator chooses to make the communication by some conducting body. A prime conductor is sometimes applied to the rubber.

Though we have produced as strong an excitation as we have ever heard of, by the amalgam of mercury and zinc, with a little tallow, as mentioned under the article Excitation, yet as many electricians, particularly the experienced Mr. Cuthbertson, prefers tin and zinc, and it is probable that this mixture may afford a speedier oxydation, we shall give his receipt.

Melt two parts of tin and zinc in a crucible, and pour them on two parts of mercury in a wooden box made for that purpose, which close and agitate till the metals are cold. Then pulverize the granulated mass very finely, and make it into a paste with hog's lard

Fig. 2, shows the plate machine, with Nicholson's cylinder improvements for changing the two states at pleasure, as adapted by Dr. Von Marum, of Haerlem.

The glass plate, G G, is fastened to the axis, B B, by means of a screw on the axis passing through a hole in the centre of the plate, and secured by a nut, C, on the opposite side. The axis is supported by a single pillar, A, which for this purpose is provided with a bearing piece, K, on which are two brass collar pieces, that carry the axis; and on the end of the axis, opposite the glass, is a counterpoise, O, of lead, to prevent too great a friction in the collar nearest the handle. The arc of the conductor, E E, which carries the two small receiving conductors, F F, is fixed to an axis turning in the ball, H. On the other side of the plate is the other arc, I, of brass wire, fixed in the bearing piece, K, but so as to admit of being turned round like the arc E E. P is a copper tube, moving like a radius on the stem of the ball, S, which, being screwed into the conductor, H, serves to confine the arm, P, in any position that may be required. The dissipation of electricity along the glass supports is prevented by a kind of cap, T, of mahogany, which affords an electrical well or cavity underneath, and likewise effectually covers the metallic cap into which the glass is cemented. The lower extremity of the pillar is guarded in the same manner by a hollow piece or ring of mahogany, V. The three glass pillars are set in sliding pieces, W W W, adjustable by screws; at each extremity of the horizontal diameter of the plate are two rubbers, X, one on each side, pressed regularly and uniformly against the plate by means of a spring, Y, the force of pressure of which is regulated by means of a screw. To these rubbers are attached silk flaps, Z Z, those of one pair of rubbers descending, and those of the other pair ascending, in the direction in which the plate is worked. A piece of fine dry writing paper, as long as the rubber, and half an inch broader, so as to cover the seam that fastens the silk to the leather, allows greater

pressure to be employed, by diminishing the friction, and prevents both the glass and silk from being soiled by the amalgam, so that the excitement is more powerful, and the amalgam requires to be renewed less frequently. As the semicircular branch of the prime conductor is moveable, it may be made to exhibit the electricity of the rubber at any time, by placing the cylindrical ends in contact with the cushions, the semicircular wire, I, being at the same time turned so as to cross it at right angles, which insulates the cushions. When the conductor is required to give electricity from the glass, the arc I must be in contact with the cushions, and the arc EE perpendicular to the horizon.

If the insulated prime conductor of a machine be well polished, and without corners or angles, it will retain its electric state very well, and will emit strong sparks upon the approach of any uninsulated conductor. If the uninsulated conductor be broad, round, and polished at the end, the sparks will be short and dense, and will produce a considerable sound; if less broad, the spark will be long, crooked, and less sounding; if the breadth be still more diminished, the conductor begins to come under the denomination of a pointed body, the electric matter passes to it from the prime conductor, through a great space of air, with a hissing or rustling noise, and in a continual stream: a still greater sharpness enables the electricity to pass over a greater space, but silently, and nothing is seen but a small light upon the point. If a similar point issue from the prime conductor, and the uninsulated conductor be round and polished, the same effects happen in like situations; but if both be pointed, the electricity is more readily discharged: and in all these cases the appearance of the electric matter at the point of the prime conductor will be that which is peculiar to its electricity, a large divergent cone, if positive, or a small globular light or cone, if negative, and the light at the point presented to the prime conductor will be distinctive of the contrary electricity. Whether a pointed conductor be electrified positively or negatively, if the nose be brought near the point during the electrization, a wind will be felt blowing from the point, and the sense will be affected with a sulphureous or phosphoreal smell.

The reaction of the force by which the air is put into motion, is exerted on the pointed body. This is shewn by a pleasing experiment with an electrified wire; thus, to the middle of the wire, or rather between two wires that lie in the same line, is affixed a centre-cap like those used in sea-compasses, so that the wire may easily be moved on a point in a horizontal direction, as magnetical needles are: and the ends of the wire are pointed and bent contrary ways, to point in the direction of the tangent to the circle described by them. Now if this wire, thus suspended on a point, be insulated and electrified, its sharp ends will become luminous, and it will revolve in a direction contrary to that in which its ends are bent; or if it be suspended on an uninsulated point, and brought near the electrified prime conductor, the same effect will follow.

It may be thought strange that the air should issue from an electrified point, whether its electricity be positive or negative. It is easy to conceive that the issuing out of the electric matter may cause the air to move in the same direction; but it appears odd, that the electric matter rushing towards a point should cause the air to move directly contrary, that is to say, likewise from the point. If, however, the circumstance be examined more narrowly, the difficulty will vanish. For it is highly probable that the electric matter passes too swiftly to excite any motion in the air, but that undulation wherein sound consists; to which may be added, that if the electric matter do act on the air to put it in motion, the air must react with an equal force; and, therefore, that a current of air blown against the course of the electric matter must affect its appearance, by retarding the rays and deflecting those against which it struck obliquely: the contrary to which is, by experience, known to obtain; for the luminous cones are not sensibly affected by such treatment. The air being thus indifferent as to the motion of the electric matter, its motion may be shewn to depend on the established principles of electricity. The point is electrified either positively or negatively, and the air immediately opposite and contiguous to the point, must, by the emission or exhaustion of the electric matter, become strongly possessed of an electric state of the same kind with that of the point: it is therefore, repelled and replaced by other air which is also electrified and repelled, by which means a constant stream is produced blowing from the point, and that equally, whether the electrization be positive or negative. And the

point repelling the air must itself also be equally repelled in the contrary direction; whence the horizontal wire above described is turned, and that always one way, namely, contrary to that in which the air is moved, or to the direction of its bent points.

If an insulated conductor, free from points, be brought within a certain distance of the prime conductor or cylinder in an electric state, it will also exhibit signs of electricity of the same kind; but if those signs be removed, by taking the spark, and the conductor taken from the prime conductor, it will exhibit signs of the contrary electricity. This is a very remarkable appearance, but may be accounted for, if two suppositions be admitted, *viz.* first, that the electric matter is attracted by conducting bodies; and secondly, that the parts of the electric matter mutually repel each other, the forces of each power being in a certain inverted ratio of the distance.

For the electric matter, in an insulated and uniform conductor, will then be equally diffused through its whole mass, and the attraction which that conductor will exert on any mass of electric matter presented from without, must be the excess of the attractive force of the body over the repulsive force of the electricity it contains. Whence a given conductor will attract the electric matter the most powerfully, when the quantity it already possesses is the least possible, and its attractive force will decrease as it becomes more saturated with electricity. Let two equal conductors, composed of like matter, be brought within a small distance of each other, then if the quantities of electricity they contain be equal, the attractions they mutually exert on those quantities will be equal, and it will remain undisturbed in each body. But if one conductor, A, contain more electricity than the other, B, the attractive power of B will be greatest, and will draw the electric matter from A, till an equilibrium is obtained. It follows, also, that in a number of conducting bodies, communicating with each other, the electric matter will be every where of the same density, if the greatest attractive force of the bodies be supposed equal; but if different bodies be supposed to attract the electric matter with different forces, as is most probable, the densities must vary with the forces. This may be called the natural state.

To apply this to the particular instance above recited, suppose the end of an insulated conductor to be brought near the prime conductor in a positive state, the attractive power of the first mentioned conductor is greater than that of the prime conductor, yet, not being sufficient to draw sparks, at the given distance, the only effect it can produce is to make the electric matter accumulate, and become more dense in that part of the prime conductor, near which it is presented; by which accumulation the rest of the prime conductor becomes less electrified, as experience testifies. This accumulated body of electricity repels, and consequently rarifies the electric matter naturally contained in that end of the conductor, which is presented to the prime conductor; the rest of the fluid becomes more dense, and the other parts of the conductor which is presented, exhibit signs of electricity; yet, as this conductor in the whole contains no more than its natural quantity, if the electric state be taken off by drawing the spark, and it be afterwards removed from the vicinity of the prime conductor, it becomes negative throughout, by reason of the loss of the spark. If a conductor be presented to the prime conductor in a negative state, the effects are reversed, the attraction being strongest at the prime conductor, and the accumulation being in the conductor which is presented, it exhibits a negative state, which, being destroyed, upon removal it becomes positive, by reason of the spark which was given to it when apparently negative.

These effects are more considerable the less the distance is between the two conductors; and the intercedent electric body is peculiarly affected: the manner of which may be better understood by observing the phenomena of non-electrics, separated by electrics which are less liable to allow the passing of the spark than the air is.

Upon an insulated horizontal plate of metal, lay a plate of glass, considerably larger, so that there may be a rim of three or four inches projecting beyond the metal on every side. Upon the glass lay another plate of metal, of the same size as the former, so as precisely to cover it. Electrify the upper plate, and the lower will exhibit signs of electricity. Continue the electrization, and the lower plate will emit sparks to an uninsulated body for a time, and afterwards cease. Separate the plates from the glass without uninsulating them, and the glass will appear to be possessed of the contrary electricities on the opposite sides. That side

which communicated with the prime conductor, during the electrization, will have a like electricity, and the other the contrary. Take off the electricity of the plates of metal, and carefully replace the glass on the lower, without destroying the insulation, and also replace the upper plate with the same precaution. Then, with one end of an insulated wire, not pointed, but knobbed at the ends, touch one of the plates, and bring the other end near the other plate: the consequence will be, that a strong and loud spark will pass between it and the wire, the electricity of the glass will be discharged, and the plates and the wire will exhibit few or no signs of electricity.

An electric body, the surfaces of which are thus possessed of the contrary electricities, is said to be charged. The insulation of the lower metallic plate, and of the discharging wire is not necessary, except for the purpose of drawing inferences, respecting the manner of charging the electric plate. If the electricity of the prime conductor be strong, and the glass thick, the discharge will often be made by a spark from the one metallic plate to the other, over the surface of the glass which projects on every side; but if the glass plate be thin, in which case, at an equal intensity, it admits of a much greater charge, the discharge will be made through its substance. Glass, as thick as one eighth of an inch, may be penetrated by this means, one or more holes being made where the electric matter has passed, in which holes the glass is pulverised, and may be picked out with a pin.

It is not possible to charge an electric plate by inducing an electric state on one of its surfaces, unless the other be at the same time sufficiently near to a non-electric to assume the contrary state, by emitting or receiving the electric matter.

If a plate of glass be laid upon an uninsulated plate of metal, the upper surface may be rendered electric by friction, or by applying an electrified body successively to its parts. This electricity may be taken off by touching the upper surface with an uninsulated metallic plate of the same dimensions as that upon which the glass is placed, but will not be entirely taken off, because the communication between the two surfaces in this method is not perfect, and because the metal cannot by ordinary means be brought into actual contact with the glass. The small quantity which remains, produces an effect which has been mistaken for a perpetual electricity. For if a plate of metal, to which a glass handle is affixed, be laid upon the glass, this small quantity of electricity will influence the metal, and, without actually communicating the electric matter, will cause it to exhibit a similar state. If this be taken off, by drawing the spark, and the metal then removed, by means of the glass handle, it will be found possessed of the contrary state of electricity, and another spark may be obtained. The metallic plate may be then again applied to the surface of the glass, and the process again repeated, and so on for a prodigious number of times, without any sensible difference in the event. For the electricity at the surface of the glass being almost in the natural state, as to condensation, does not disappear for a very long time, and the very near approach of the metal enables it to produce the same effect as would be obtained at a greater distance from a stronger electricity. This is made obvious, by bringing the metallic plate near the surface of the glass before its first strong electricity is taken off, for the same event is then perceived at the distance of four, five, or six inches, as in the former case is produced by contact.

The vapours of the atmosphere are continually attaching themselves to the surface of cold glass, and by that means destroy the electricity. Sulphur, wax, or resin, being less subject to this, retain their electric state much longer. A plate of glass or wood, coated over with any substance of this nature, may be excited by friction, and will produce electricity in a metallic plate, in the manner above described, for a very great length of time. Such a plate, together with its metal, has been named the electrophophorus, fig. 3.

If the discharge of an electrified plate be made by the parts of a living animal, a considerable pain will be felt, chiefly at the extremities of the muscles. For example, if the lower metallic plate be touched with one hand, and the other brought to the upper plate, at the instant of the emission, a pain will be felt at the wrist and elbows, which as instantly vanishes. If a larger glass plate be used, the pain will be felt on the breast; if yet larger, the sensation will be that of a universal blow. This sensation has obtained the name of the shock, and will deprive animals of life, if sufficiently strong. The shock from thirty square inches of glass, well charged, will instantly kill mice, sparrows, or other small animals. Six

square feet of glass will deprive a man of sensation for a time, if the head be made a part of the circuit through which the electricity moves. No inconvenience has been found from the electric shock by men of strong habits; but women of delicate constitutions have had convulsions from a violent shock. It may be observed, that the electric shock is a proof that the electric matter can pass through the substance of non-electrics, and is not universally conducted along the surfaces alone, as some have supposed.

The object of the philosopher being, in general, to collect a large quantity of electricity, by means of the surfaces of electrics, it is more usual to employ jars, and not plates. These are made of various shapes and magnitudes; but the most useful are thin cylindrical glass vessels, about four inches in diameter, and fourteen in height, coated within and without with tin-foil, which is stuck on with gum-water, paste, or wax, excepting two inches of the rim or edge, which is left bare, to prevent the communication between the coatings. About four inches from the bottom, within, is a large cork, that receives a thick wire, ending in several ramifications, which touch the inside coating; the upper end of the wire terminating with a knob, considerably above the mouth of the jar, fig. 4. When it is required to be charged, it may be held in the hand, or placed on an uninsulated table, and the knob of the wire applied to the conductor; the inside coated surface becomes possessed of the electricity of the conductor, and the external surface acquires the contrary electricity, by means of its uninsulated coating. When a jar of this kind is highly charged, it will discharge spontaneously over the uncoated surface, and seldom through the glass; whereas, when the uncoated surface is large, it is more apt to break by that means, and become useless. Yet there is no certainty that a jar, which has discharged itself over its surface, will not at another time break by a discharge through the glass, as the contrary often happens. If paper covered with tin-foil be used for the coating, with the paper next the glass, the jar will be less liable to break.

A jar of considerable thickness, with a neck like a bottle, in which is cemented a thick tube to receive the wire, will sustain a very high charge, and produce much greater effects than one of the last description. The charging wire being inserted loosely into the tube, will fall out on inverting the jar, and the charge will remain for several weeks without much loss. A jar thus charged, may be put into the pocket, and applied to many purposes that the common jar cannot be used for.

If the inside of the jar be considerably damped, by blowing into it, through a tube reaching to the bottom, it will take a charge nearly one-third greater than in the ordinary state.

When a greater degree of electric force is required, larger jars must be used, in which the form is of no consequence, except as far as relates to convenience. But it is less expensive, and nearly as effectual, to use a number of smaller jars, having the same quantity of coated surface as the large jars. In this case, a communication must be formed between all the outside coatings, which may be done by placing them on a stand of metal; and also between all the inner coatings, which is best done by means of wires. Such a collection is called a battery, and may be charged and discharged like a single jar, fig. 5.

In discharging electrical jars, the electricity goes in the greatest quantity through the best conductors, and by the shortest course. Thus, if a chain and a wire, communicating with the outer coating, be presented to the knob of a jar, the greater part of the charge will pass by the wire, and very little by the chain, which is a worse conductor, by reason of its discontinuation at every link. When the discharge is made by the chain only, sparks are seen at every link, which is a proof that they are not in contact; and as the chain must be stretched by a considerable force before the sparks cease to appear on the discharge, it follows, that there is a repulsive power in bodies, by which they are prevented from coming into contact, unless by means of a certain force.

By accurate experiments, it appears, that the force of the electric shock is weakened, that is, its effects are diminished, by using a conductor of great length in making the discharge. Dr. Watson, and other gentlemen of eminence in the philosophical world, were at the pains of making experiments of the same kind, but much more accurate. They found, by means of wire insulated on baked wood, that the electric shock was transmitted instantaneously through the length of 12,276 feet.

When any animal or substance is to be subjected to the shock, it is done by means of two chains, one of which connects one extremity of the animal or substance with the outer coating, and the

other being made to touch the other extremity, is applied to the knob of the inner coating, to make the discharge. The animal or substance thus forming a part of the circuit, receives the whole shock. The strong shock of a battery will melt wire of the seventieth of an inch in diameter, and wires of less diameters are frequently blown away and dispersed; and the effect is the same with equal quantities of electricity, whether the intensity be greater or less, within certain extended limits. Gunpowder may be fired by a charge of three square feet: the method is, to put it into a quill, and thrust a wire into each end, so as not to meet, and then make these wires a part of the circuit. A less charge will serve, if iron filings be mixed with the gunpowder. Alcohol, ether, or a mixture of common air and hydrogen, may also be fired by the same means, or even by the spark from the conductor.

If the ball of a thermometer be placed in a strong current of electricity, the mercury or spirit will rise many degrees.

If a thin bottle be exhausted of air by means of the air-pump, it will receive a considerable charge by applying its bottom to the electrified prime conductor, during which time the electric matter will pass through the vacuum between the hand and the inner surface of that part of the glass which is nearest the prime conductor. This appearance is exceedingly beautiful in the dark, especially if the bottle be of a considerable length. It exactly resembles those lights which appear in the northern sky, and are called streamers, or the aurora borealis. If one hand be applied to the part of the bottle which was applied to the conductor, while the other remains at the neck, the shock will be felt, at which instant the natural state of the inner surface is restored by a flash, which is seen pervading the vacuum between the two hands.

MACHINERY, in epic and dramatic poetry, is when the poet introduces the use of machines, or brings some supernatural being upon the stage, in order to solve some difficulty, or to perform some exploit out of the reach of human power. The ancient dramatic poets never made use of machines, unless where there was an absolute necessity for so doing; whence the precept of Horace,

"Nec Deus intersit, nisi dignus vindice nodus—inciderit.

It is quite otherwise with epic poets, who introduce machines in every part of their poem; so that nothing is done without the intervention of the gods. In Milton's Paradise Lost, by far the greater part of the actors are supernatural personages: Homer and Virgil do nothing without them; and in Voltaire's Henriade, the poet has made excellent use of Saint Louis.

MACKREL, in ichthyology. See Icomber.

MACLAURIN (Colin,) in biography, a most eminent mathematician and philosopher, was the son of a clergyman, and born at Kilmoddan in Scotland, in the year 1698. He was sent to the university of Glasgow in 1709; where he continued five years, and applied to his studies in a very intense manner, and particularly to the mathematics. His great genius for mathematical learning discovered itself so early as twelve years of age; when, having accidentally met with a copy of "Euclid's Elements" in a friend's chamber, he became in a few days master of the first six books without any assistance; and, it is certain, that in his sixteenth year he had invented many of the propositions which were afterwards published as part of his work, entitled, "Geometriæ Organica." In his fifteenth year he took the degree of Master of Arts; on which occasion he composed, and publicly defended, a thesis on the power of gravity, with great applause. After this he quitted the university, and retired to a country seat of his uncle, who had the care of his education; his parents being dead some time. Here he spent two or three years in pursuing his favourite studies; but in 1717, at nineteen years of age only, he offered himself a candidate for the professorship of mathematics in the Marischal College of Aberdeen, and obtained it after a ten day's trial, against a very able competitor.

In 1719, Mr. Maclaurin visited London, where he left his "Geometria Organica" to print, and where he became acquainted with Dr. Hoadley, then bishop of Bangor, Dr. Clarke, Sir Isaac Newton, and other eminent men, at which time also he was admitted a member of the Royal Society; and in another journey in 1721, he contracted an intimacy with Martin Folkes, Esq. the president of it, which continued during his whole life.

In 1722, Lord Polworth, plenipotentiary of the King of Great Britain at the congress of Cambray, engaged Maclaurin to go as a tutor and companion to his

eldest son, who was then to set out on his travels. After a short stay at Paris, and visiting other towns in France, they fixed in Lorrain, where he wrote his piece on the percussion of bodies, which gained him the prize of the Royal Academy of Sciences for the year 1724 But his pupil dying soon after at Montpelier, he returned immediately to his profession at Aberdeen. He was hardly settled here when he received an invitation to Edinburgh; the curators of that university being desirous that he should supply the place of Mr. James Gregory, whose great age and infirmities had rendered him incapable of teaching. He had here some difficulties to encounter, arising from competitors, who had good interest with the patrons of the university, and also from the want of an additional fund for the new professor; which, however, at length were all surmounted, principally by the means of Sir Isaac Newton. Accordingly, in November 1725, he was introduced into the university, as was at the same time his learned colleague and intimate friend, Dr. Alexander Munro, professor of anatomy. After this, the mathematical classes soon became very numerous, there being generally upwards of one hundred students attending his lectures every year; who being of different standings and proficiency, he was obliged to divide them into four or five classes, in each of which he employed a full hour every day, from the first of November to the first of June. In the junior class he taught the first six books of "Euclid's Elements," plane trigonometry, practical geometry, the elements of fortification, and an introduction to algebra. The second class studied algebra, with the eleventh and twelfth books of Euclid, spherical trigonometry, conic sections, and the general principles of astronomy. The third went on in astronomy and perspective, read a part of "Newton's Principia," and had performed a course of experiments for illustrating them; he afterwards read and demonstrated the elements of fluxions. Those in the fourth class read a system of fluxions, the doctrine of chances, and the remainder of "Newton's Principia."

In 1734, Dr. Berkley, Bishop of Cloyne, published a piece called the "Analyst," in which he took occasion, from some disputes that had arisen concerning the grounds of the fluxionary method, to explode the method itself; and also to charge mathematicians in general with infidelity in religion. Maclaurin thought himself included in this charge, and began an answer to Berkley's book; but other answers coming out, and as he proceeded, so many discoveries, so many new theories and problems occurred to him, that instead of a vindicatory pamphlet, he produced a complete system of fluxions, with their application to the most considerable problems in geometry and natural philosophy. This work was published at Edinburgh in 1742, 2 vols. 4to.; and as it cost him infinite pains, so it is the most considerable of all his works, and will do him immortal honour, being indeed the most complete treatise on that science that has yet appeared.

In the mean time, he was continually obliging the public with some observation or performance of his own, several of which were published in the fifth and sixth volumes of the Medical Essays at Edinburgh. Many of them were likewise published in the Philos. Trans. as the following: 1. On the construction and measure of curves, vol. 30.—2. A new method of describing all kinds of curves, vol. 30.—3. On equations with impossible roots, vol. 34.—4. On the roots of equations, &c. vol. 34.—5. On the description of curve lines, vol. 39.—6. Continuation of the same, vol. 39.—7. Observations on a solar eclipse, vol. 40.—8 A rule for finding the meridional parts of a spheroid, with the same exactness as in a sphere, vol. 41.—9. An account of the treatise of fluxions, vol. 42.—10. On the basis of the cells, where the bees deposit their honey, vol. 42.

In the midst of these studies, he was always ready to lend his assistance in contriving and promoting any scheme which might contribute to the public service. When the Earl of Morton went, in 1739, to visit his estates in Orkney and Shetland, he requested Mr. Maclaurin to assist him in settling the geography of those countries, which is very erroneous in all our maps; to examine their natural history, to survey the coasts, and to take the measure of a degree of the meridian. Maclaurin's family affairs would not permit him to comply with this request; he drew up however a memorial of what he thought necessary to be observed, and furnished proper instruments for the work, recommending Mr. Short, the noted optician, as a fit operator for the management of them.

Mr. Maclaurin had still another scheme for the improvement of geography and navigation, of a more extensive nature;

which was, the opening a passage from Greenland to the South Sea by the north pole. That such a passage might be found, he was so fully persuaded, that he used to say, if his situation could admit of such adventures, he would undertake the voyage, even at his own charge. But when schemes for finding it were laid before the parliament in 1741, and he was consulted by several persons of high rank concerning them, and before he could finish the memorial he proposed to send, the premium was limited to the discovery of a north-west passage; and he used to regret that the word west was inserted, because he thought that passage, if at all to be found, must lie not far from the pole.

In 1745, having been very active in fortifying the city of Edinburgh against the rebel army, he was obliged to fly from thence into England, where he was invited by Dr. Herring, Archbishop of York, to reside with him during his stay in this country. In this expedition, however, being exposed to cold and hardships, and naturally of a weak and tender constitution, which had been much more enfeebled by close application to study, he laid the foundation of an illness which put an end to his life, in June 1746, at forty-eight years of age, leaving his widow with two sons and three daughters.

Mr. Maclaurin was a very good, as well as a very great man, and worthy of love as well as admiration. His peculiar merit as a philosopher was, that all his studies were accommodated to general utility; and we find, in many places of his works, an application, even of the most abstruse theories, to the perfecting of mechanical arts. For the same purpose he had resolved to compose a course of practical mathematics, and to rescue several useful branches of the science from the ill treatment they often met with in less skilful hands. These intentions however were prevented by his death; unless we may reckon, as a part of his intended work, the translation of Dr. David Gregory's Practical Geometry, which he revised, and published with additions, in 1745.

In his life-time, however, he had frequent opportunities of serving his friends and his country by his great skill. Whatever difficulty occurred concerning the constructing or perfecting of machines, the working of mines, the improving of manufactures, the conveying of water, or the execution of any public work, he was always ready to resolve it. He was employed to terminate some disputes of consequence that had arisen at Glasgow, concerning the gauging of vessels; and for that purpose presented to the commissioners of the excise two elaborate memorials, with their demonstrations, containing rules by which the officers now act. He made also calculations relating to the provision, now established by law, for the children and widows of the Scotch clergy, and of the professors in the universities, entitling them to certain annuities and sums, upon the voluntary annual payment of a certain sum by the incumbent. In contriving and adjusting this wise and useful scheme, he bestowed a great deal of labour, and contributed not a little towards bringing it to perfection.

Of his works, we have mentioned his "Geometrica Organica," in which he treats of the description of curve lines by continued motion; as also of his piece which gained the prize of the Royal Academy of Sciences in 1724. In 1740, he likewise shared the prize of the same academy with the celebrated D. Bernoulli and Euler, for resolving the problem relating to the motion of the tides from the theory of gravity, a question which had been given out the former year without receiving any solution. He had only ten days to draw this paper up in, and could not find leisure to transcribe a fair copy; so that the Paris edition of it is incorrect. He afterwards revised the whole, and inserted it in his treatise of fluxions; as he did also the substance of the former piece. These, with the treatise of fluxions, and the pieces printed in the Medical Essays, and the Philos. Trans. a list of which is given above, are all the writings which our author lived to publish.

Since his death, however, two more volumes have appeared; his algebra, and his account of Sir Isaac Newton's philosophical discoveries. The algebra, though not finished by himself, is yet allowed to be excellent in its kind; containing, within a moderate compass, a complete elementary treatise of that science, as far as it has hitherto been carried; besides some neat analytical papers on curve lines. His account of Newton's philosophy was occasioned in the following manner. Sir Isaac dying in the beginning of 1728, his nephew, Mr. Conduitt, proposed to publish an account of his life, and desired Mr. Maclaurin's assistance. The latter, out of gratitude to his great benefactor, cheerfully undertook, and soon finished, the

history of the progress which philosophy had made before Newton's time; and this was the first draught of the work in hand; which not going forward, on account of Mr. Conduitt's death, was returned to Mr. Maclaurin. To this he afterwards made great additions, and left it in the state in which it now appears. His main design seems to have been, to explain only those parts of Newton's philosophy which have been controverted; and this is supposed to be the reason why his grand discoveries concerning light and colours are but transiently and generally touched upon; for it is known, that whenever the experiments on which his doctrine of light and colours is founded had been repeated with due care, this doctrine had not been contested; while his accounting for the celestial motions, and the other great appearances of nature, from gravity, had been misunderstood, and even attempted to be ridiculed.

MACQUER (Joseph), in biography, an eminent chemist, was born at Paris in 1710. He was brought up to physic, and became a doctor of the faculty of medicine, in the university of Paris, professor of pharmacy, and censor royal. He was also a member of the academies of sciences of Turin, Stockholm, and Paris, and he held the medical and chemical departments in the Journal des Savans. M. Macquer made himself well known by several useful and popular works on chemistry, of which science he was one of the most successful cultivators on the modern rational plan, before the new modelling which it has received of late years. His publications were, "Elemens de Chymie Pratique," two vols. 12mo. 1751–1756. "Plan d'un Cours de Chymie experimentale et raisonnée," 12mo. 1757. This was drawn up in conjunction with M. Baumé, who lectured on chemistry in partnership with him; "Dictionnaire de Chymie," two vols. 8vo. 1766. These works have been translated into English and German: the dictionary, particularly, by Mr. Keir, with great additions and improvements. He wrote likewise "Formulæ Medicamentorum Magistralium," 1763; and "L'Art de la Teinture de Soie," 1763; and he had a share in the "Pharmacopeia Parisiensis," of 1758. This meritorious writer died in 1784. Dict. Hist. de la Med. par Eloy. Nouv. Dict. Hist.

MACROCEPHALUS, in natural history, a genus of insects of the order Hemiptera: snout inflected; the sheath one-valved, three jointed, and furnished with three bristles; antennæ projecting, very short, submoniliform, clavate; head oblong, cylindrical above; scutel as long as the abdomen, depressed, membranaceous. There is only one species, *viz.* M. cimicoides, found in North America; the body is a ferruginous grey; scutel pale ash with a yellow rigid spot; under-wings purplish violet; fore-shanks thickened.

MACROCNEMUM, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Rubiaceæ, Jussieu. Essential character: corolla bell-shaped; capsule two-celled, two valved, with the valves gaping outwardly at the sides; seeds imbricate. There are three species.

MACROLOBIUM, in botany, a genus of the Triandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx double, outer two-leaved, inner one-leaved; petals five, upper one very large, the rest small, equal; germ pedicelled, legume. There are three species, all of them tall trees, from sixty to eighty feet in height; they are natives of the large forests of Guiana.

MACROPUS, the *kanguroo*, in natural history, a genus of mammalia of the order Feræ. Generic character: six front teeth in the upper jaw, emarginated; two in the lower, and very long, sharp, large, and pointing forwards; five grinders on each side of the upper and under jaw, distant from the other teeth; fore legs very short; hind ones very long; the female with an abdominal pouch. This is one of the most curious of all the animals discovered on the continent of New South Wales, where it was observed by some of the sailors of Captain Cook in the year 1770. When full grown, it weighs about 150 pounds. Its head somewhat resembles that of a deer, but is destitute of horns; its countenance is gentle and complacent; its colour is of a pale brown; its length from the nose to the tail is between four and five feet, and the length of the tail is about three feet. Its general position, when resting, is that of standing on its hind feet, on their whole extent to the knees, and its fore feet are frequently employed, like those of the squirrel, as hands. They are often, however, laid on the ground, and the kanguroo is often seen in this posture, feeding. Vegetables, and particularly grass, constitute its only nourishment. In its rapid motions, however, the fore

feet are wholly useless, and it proceeds by leaping on its hind feet, which it will do to the distance of fourteen or sixteen feet, and with bounds so rapid in succession, that it exceeds in swiftness a common dog. Kanguroos possess the faculty of separating at pleasure the two front teeth of their lower jaw; and the female is furnished with a pouch in the abdomen, of extraordinary depth, in which are placed two teats. But one young one is produced at a time, which, when first observed in the pouch, after its birth, is scarcely more than an inch in length, but grows to a considerable size in this natural receptacle before it quits it, and frequently recurs to it for warmth and security after its first dislodgment from it. This animal is in this striking circumstance allied to the opossum genus, under which Gmelin ranks it, but it differs from the opossum materially in respect to the structure of the teeth. In its general appearance it strongly resembles the jerboa. It was the only quadruped which Australasia supplied to the English colonists for food. It has been not only imported into England, but has repeatedly bred in that country, and may be considered as now naturalized; and though not apparently convertible to any important service, exhibits a very interesting variety to the observer of nature. Many of these animals are kept in the royal premises at Kew, where those unacquainted with their form and habits may be easily gratified by a sight of them in various stages of growth, and bounding before him with a vivacity and elasticity highly entertaining. See Mammalia, Plate IX. fig. 3.

MACTRA, in natural history, a genus of the Vermes Testacea class and order. Animal a tethys; shell bivalve, unequal sided, equivalve; middle tooth of the hinge complicated, with a small hollow on each side; lateral ones remote and inserted into each other. There are twenty-seven species.

MACULÆ, in astronomy, dark spots appearing on the luminous faces of the sun, moon, and even some of the planets; in which sense they stand contradistinguished from faculæ. See FACULÆ.

These spots are most numerous and easily observed in the sun. It is not uncommon to see them in various forms, magnitudes, and numbers, moving over the sun's disc. They were first of all discovered by astronomer Galileo, in the year 1610, soon after he had finished his new-invented telescope. It has been supposed that these spots adhere to, or float upon, the surface of the sun, for the following reasons. 1. Many of them are observed to break out near the middle of the sun's disc; others to decay and vanish there, or at some distance from his limb. 2. Their apparent velocities are always greatest over the middle of the disc, and gradually slower from thence on each side towards the limb. 3. The shape of the spots varies according to their position on the several parts of the disc: those which are round and broad in the middle, grow oblong and slender as they approach the limb, according as they ought to appear by the rules of optics.

By comparing many observations of the intervals of time in which the spots made their revolution, by Galileo, Cassini, Scheiner, Hevelius, Dr. Halley, Dr. Derham, and others, it is found that 27 days, 12 hours, 20 minutes, is the measure of one of them at a mean; but in this time the earth describes the angular motion of 26° 22′, about the sun's centre: therefore say, as the angular motion of 360° + 26° 22′, is to 360°; so is 27 days, 12 hours, 20 minutes, to 25 days, 15 hours, 16 minutes; which, therefore, is the time of the sun's revolution about its axis.

As to the magnitude of the spots, they are very considerable, as will appear if we observe that some of them are so large as to be plainly visible to the naked eye: thus Galileo saw one of them in the year 1612; and Mr. Martin assures us, that he knew two gentlemen that thus viewed them several years ago; whence he concludes, that these spots must therefore subtend, at least, an angle of one minute. Now the diameter of the earth, if removed to the sun, would subtend an angle of but 20″; so that the diameter of a spot, just visible to the naked eye, is, to the diameter of the earth, as 60 to 20, or as 3 to 1; and, therefore, the surface of the spot, if circular, to a great circle of the earth, is as 9 to 1; but 4 great circles are equal to the earth's superficies; whence the surface of the spot is, to the surface of the earth, as 9 to 4; or as $2\frac{1}{4}$ to 1. Gassendus says, he saw a spot whose diameter was equal to $\frac{1}{20}$ of that of the sun, and therefore subtended an angle at the eye of 1′ 30″; its surface must have been five times larger than the surface of the whole earth. What these spots are, it is presumed, nobody can tell; but they seem to be rather thin substances than solid bodies, because they lose the appearance of solidity in going off the disc of the sun: they resemble something of the nature of scum or scoria,

swimming on the surface, which are generated and dissolved by causes little known to us: but whatever these solar spots are, it is certain they are produced from causes very inconstant and irregular; for Scheiner says he frequently saw fifty at once, but for twenty years after scarce any appeared. And in the last century the spots were very frequent and numerous till the year 1741, when, for three years successively, very few appeared; and now, since the year 1744, they have again appeared as usual.

These maculæ are not peculiar to the sun, they have been observed in all the planets. Thus Venus was observed to have several by Signior Blanchini, in the year 1726. As in Venus, so in Mars, both dark and bright spots have been observed, first by Galileo, and afterwards by Cassini, &c. Jupiter has had his spots observable ever since the invention and use of large telescopes. Saturn, by reason of his great distance on one hand, and Mercury, by reason of his smallness and vicinity to the sun on the other, have not as yet had any spots discovered on their surfaces, and consequently nothing in relation to their diurnal motions and inclinations of their axis to the planes of their orbits can be known, which circumstances are determined in all the other planets, as well as in the sun, by means of these maculæ.

The spots, or maculæ, observable on the moon's surface, seem to be only cavities or large caverns, on which the sun shining very obliquely, and touching only their upper edge with his light, the deeper places remain without light; but as the sun rises higher upon them, they receive more light, and the shadow, or dark parts, grow smaller and shorter, till the sun comes at last to shine directly upon them, and then the whole cavity will be illustrated: but the dark dusky spots, which continue always the same, are supposed to proceed from a kind of matter or soil which reflects less light than that of the other regions. See Moon.

MADDER is a plant, with rough narrow leaves, set in form of a star, at the joints of the stalk. The root, which is the only part made use of, is long, slender, of a red colour, both on the outside and within, excepting a whitish pith which runs along the middle. For cultivating this plant, the ground is ploughed deep in autumn, and again in March; and then laid up in ridges, eighteen inches asunder, and about a foot high. About the beginning of April, they open the ground where old roots are planted, and take off all the side shoots which extend themselves horizontally; these they transplant immediately upon the new ridges, at about a foot distance, where they remain two seasons: and at Michaelmas, when the tops of the plants are decayed, they take up the roots. It is to be observed, that this method of planting in ridges is only necessary in wet land, and that the rows are sometimes planted three feet, and the plants in the rows eighteen inches asunder. If all the horizontal roots are destroyed from time to time, it will cause the large, downright roots, to be much bigger, in which the goodness of this commodity chiefly consists. Madder gives out its colour, both to water and rectified spirit: the watery tincture is of a dark dull red; the spirituous of a deep bright one. It imparts to woollen cloth, prepared with alum and tartar, a very durable, though not a very beautiful red dye. As it is the cheapest of all the red drugs that give a durable colour, it is the principal one commonly made use of for ordinary stuffs. Sometimes its dye is heightened by the addition of Brazil-wood, and sometimes it is employed in conjunction with the dearer reds, as cochineal; for demi-scarlets, and demi-crimsons.

MADREPORA, in natural history, a genus of the Vermes Zoophyta class and order. Animal resembling a medusa; coral with lamellate star-shaped cavities. This is a very numerous genus, comprehending about 120 species, separated into distinct divisions. A. composed of a single star. B. with numerous separate stars, and continued gills. C. with numerous united stars. D. aggregate, undivided, with distinct stars and porulous tuberculous prominent undulations. E. branched, with distinct stars and tuberculous porulous undulations. M. verrucaria, star orbicular, flattish, sessile, with a convex disc full of tubular pores and radiate border: it inhabits the European, Mediterranean, and Red Seas, adhering to marine vegetables and the softer zoophytes; size of a split-pea, and appears an intermediate species between the madrepore, tubipore, and millepore; white or yellowish, with aggregate tubes on the disc like the florets of a composite flower, and a flattened striate border like the rays of these flowers. A. ananas, with angular convex stars, which are concave on the disc, inhabits the Mediterranean and South American Sea, and is frequently found fossile; gibbous, and when dissected transversely, resembling a white

net with hexangular spots, including a white ring, and striate between the net and ring. See ZOOPHYTA.

MADREPORITE, a mineral found in the valley of Russback, in Salzburg, and so called from its external resemblance to madrepore. It is found in large masses, is brittle and moderately heavy. Its component parts are,

Carbonate of lime . . .	93.00
Carbonate of magnesia .	0.50
Carbonate of iron . . .	2.25
Charcoal	0.50
Silica	4.50
	99.75
Loss . .	25
	100

MADRIER, in the military art, a long and broad plank of wood, used for supporting the earth in mining and carrying on a sap, and in making coffers, caponiers, galleries, and for many other uses at a siege. Madriers are also used to cover the mouths of petards, after they are loaded, and are fixed with the petards to the gates or other places designed to be forced open.

MADRIGAL, in the Italian, Spanish, and French poetry, is a short amorous poem, composed of a number of free and unequal verses, neither confined to the regularity of a sonnet, nor to the point of an epigram, but only consisting of some tender and delicate thought, expressed with a beautiful, noble, and elegant simplicity. The madrigal is usually considered as the shortest of all the lesser kinds of poetry, except the epigram: it will admit of fewer verses than either the sonnet or the roundelay; no other rule is regarded in mingling the rhymes, and the different kinds of verse, but the fancy and convenience of the author: however, this poem allows of less licence than many others, both with respect to rhyme, measure, and delicacy of expression.

MAGAZINE, a place in which stores are kept, of arms, ammunition, provisions, &c. Every fortified town ought to be furnished with a large magazine, which should contain stores of all kinds, sufficient to enable the garrison and inhabitants to hold out a long siege, and in which smiths, carpenters, wheelrights, &c. may be employed, in making every thing belonging to the artillery, as carriages, waggons, &c.

MAGAZINE, *powder*, a place in which powder is kept in large quantities, and which, on account of the nature of the substance preserved, should be arched and bomb-proof. According to the plan of Vauban, they are sixty feet long and twenty-five broad in the inside. The foundations are eight or nine feet thick, and about as many feet high from the foundation to the spring of the arch. As some inconveniencies have arisen from this structure, Dr. Hutton proposes to find an arch of equilibration, which he would have constructed to a span of twenty feet, the pitch being ten feet; the exterior walls at top forming an angle of 113°, and the height of the angular point above the top of the arch to be seven feet.

MAGGOT. See MUSCA.

MAGI, or MAGIANS, an ancient religious sect in Persia, and other eastern countries, who maintained, that there were two principles, the one the cause of all good, the other the cause of all evil; and abominating the adoration of images, worshipped God only by fire, which they looked upon as the brightest and most glorious symbol of Oromasdes, or the good God; as darkness is the truest symbol of Arimanius, or the evil god. This religion was reformed by Zoroaster, who maintained that there was one supreme independent being; and under him two principles or angels, one the angel of goodness and light, and the other of evil and darkness: that there is a perpetual struggle between them, which shall last to the end of the world; that then the angel of darkness and his disciples shall go into a world of their own, where they shall be punished in everlasting darkness; and the angel of light and his disciples shall also go into a world of their own, where they shall be rewarded in everlasting light. The priests of the magi were the most skilful mathematicians and philosophers of the ages in which they lived, insomuch that a learned man and a magian became equivalent terms. The vulgar looked on their knowledge as more than natural, and imagined them inspired by some supernatural power; and hence those who practised wicked and mischievous arts, taking upon themselves the name of magians, drew on it that ill signification which the word magician now bears among us. This sect still subsists in Persia, under the denomination of gaurs, where they watch the sacred fire with the greatest care, and never suffer it to be extinguished. See GAURS.

MAGIC, originally signified only the knowledge of the more sublime parts of philosophy; but as the magi likewise professed astrology, divination, and sorcery, the term magi became odious, being used to signify an unlawful diabolical kind of science, acquired by the assistance of the devil and departed souls. See ASTROLOGY, NECROMANCY, &c.

Natural magic is only the application of natural philosophy to the production of surprising but yet natural effects. The common natural magic, found in books, gives us merely some childish and superstitious traditions of the sympathies and antipathies of things, or of their occult and peculiar properties; which are usually intermixed with many trifling experiments, admired rather for their disguise than for themselves.

MAGIC *lantern.* See LANTERN.

MAGIC *square,* in arithmetic, a square figure made up of numbers in arithmetical proportion, so disposed in parallel and equal ranks, that the sums of each row, taken either perpendicularly, horizontally, or diagonally, are equal: thus,

Natural square.

1	2	3
4	5	6
7	8	9

Magic square.

2	7	6
9	5	1
4	3	8

Magic squares seem to have been so called, from their being used in the construction of talismans.

Take another instance:

Natural square.

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	4	25

Magic square.

16	14	8	2	25
3	22	20	11	9
15	6	4	23	17
24	18	12	10	1
7	5	21	19	13

where every row and diagonal in the magic square makes just the sum 65, being the same as the two diagonals of the natural square.

It is probable that these magic squares were so called, both because of this property in them, *viz.* that the ranks in every direction make the same sum, appeared extremely surprising, especially in the more ignorant ages, when mathematics passed for magic, and because also of the superstitious operations they were employed in, as the construction of talismans, &c.; for, according to the childish philosophy of those days, which ascribed virtues to numbers, what might not be expected from numbers so seemingly wonderful? The magic square was held in great veneration among the Egyptians, and the Pythagoreans, their disciples, who, to add more efficacy and virtue to this square, dedicated it to the then known seven planets divers ways, and engraved it upon a plate of the metal that was esteemed in sympathy with the planet. The square, thus dedicated, was inclosed by a regular polygon, inscribed in a circle, which was divided into as many equal parts as there were units in the side of the square; with the names of the angles of the planet, and the signs of the zodiac, written upon the void spaces between the polygon and the circumference of the circumscribed circle. Such a talisman or metal they vainly imagined would, upon occasion, befriend the person who carried it about him. To Saturn they attributed the square of 9 places or cells, the side being 3, and the sum of the numbers in every row 15: to Jupiter the square of 16 places, the side being 4, and the amount of each row 34: to Mars the square of 25 places, the side being 5, and the amount of each row 65: to the sun the square with 36 places, the side being 6, and the sum of each row 111: to Venus the square of 49 places, the side being 7, and the amount of each row 175: to Mercury the square with 64 places, the side being 8, and the sum of each row 260: and to the moon the square of 81 places, the side being 9, and the amount of each row 369. Finally, they attributed to imperfect matter, the square with 4 divisions, having 2 for its side; and to God, the square of only one cell, the side of which is also an unit, which multiplied by itself undergoes no change. To form a magic square of an odd number of terms in the arithmetic progression 1, 2, 3, 4, &c. place the least term 1 in the cell immediately under the middle or central one; and the rest of the terms, in their natural order, in a descending diagonal direction, till they run off either at the bottom, or on the side: when the

number runs off at the bottom, carry it to the uppermost cell, that is not occupied, of the same column that it would have fallen in below, and then proceed descending diagonalwise again as far as you can, or till the numbers either run off at bottom or side, or are interrupted by coming at a cell already filled: now when any number runs off at the right-hand side, then bring it to the furthest cell on the left-hand of the same row or line it would have fallen in towards the right-hand: and when the progress diagonalwise is interrupted by meeting with a cell already occupied by some other number, then descend diagonally to the left from this cell till an empty one is met with, where enter it; and thence proceed as before. Thus,

To make a magic square of the 49 numbers 1, 2, 3, 4, &c.

22	47	16	41	10	35	4
5	23	48	17	42	11	29
30	6	24	49	18	36	12
13	31	7	25	43	19	37
38	14	32	1	26	44	20
21	39	8	33	2	27	45
46	15	40	9	34	3	28

First place the 1 next below the centre cell, and thence descend to the right till the 4 runs off at the bottom, which therefore carry to the top corner on the same column as it would have fallen in; but as that runs off at the side, bring it to the beginning of the second line, and thence descend to the right till they arrive at the cell occupied by 1; carry the 8 therefore to the next diagonal cell to the left, and so proceed till 10 runs off at the bottom, which carry therefore to the top of its column, and so proceed till 13 runs off at the side, which therefore bring to the beginning of the same line, and thence proceed till 15 arrives at the cell occupied by 8; from this therefore descend diagonally to the left; but as 16 runs off at the bottom, carry it to the top of its proper column, and thence descend till 21 runs off at the side, which is therefore brought to the beginning of its proper line; but as 22 arrives at the cell occupied by 15, descend diagonally to the left, which brings it into the first column, but off at the bottom, and therefore it is carried to the top of that column; thence descending till 29 runs off both at bottom and side, which therefore carry to the highest unoccupied cell in the last column; and here, as 30 runs off at the side, bring it to the beginning of its proper column, and thence descend till 35 runs off at the bottom, which therefore carry to the beginning or top of its own column; and here, as 36 meets with the cell occupied by 29, it is brought from thence diagonally to the left; thence descending, 38 runs off at the side, and therefore it is brought to the beginning of its proper line; thence descending, 41 runs off at the bottom, which therefore is carried to the beginning or top of its column; from whence descending, 43 arrives at the cell occupied by 36, and therefore it is brought down from thence to the left; thence descending, 46 runs off at the side, which therefore is brought to the beginning of its line; but here, as 47 runs off at the bottom, it is carried to the beginning or top of its column, from whence descending with 48 and 49, the square is completed, the sum of every row and column and diagonal making just 175. Dr. Franklin carried this curious speculation further than any of his predecessors in the same way. He constructed both a magic square of squares, and a magic circle of circles, the description of which is as follows. The magic square of squares is formed by dividing the great square into 256 little squares, in which all the numbers from 1 to 256, or the square of 16, are placed, in 16 columns, which may be taken either horizontally or vertically. Their chief properties are as follow. 1. The sum of the 16 numbers in each column or row, vertical or horizontal, is 2056. 2. Every half column, vertical and horizontal, makes 1028, or just one half of the same sum 2056. 3. Half a diagonal ascending, added to half a diagonal descending, makes also the same sum 2056; taking these half diagonals from the ends of any side of the square to the middle of it; and so reckoning them either upward or downward, or sideways from right to left, or from left to right. 4. The same with all the parallels to the half diagonals, as many as can be drawn in the great square: for any two of them being directed upward and downward, from the place where they begin, to that where they end, their sums still make the same

2056. Also the same holds true downward and upward; as well as if taken sideways to the middle, and back to the same side again. Only one set of these half diagonals and their parallels, is drawn in the same square upward and downward; but another set may be drawn from any of the other three sides. 5. The four corner numbers in the great square, added to the four central numbers in it, make 1028, the half sum of any vertical or horizontal column, which contains 16 numbers; and also equal to half a diagonal or its parallel. 6. If a square hole, equal in breadth to four of the little squares or cells, be cut in a paper, through which any of the 16 little cells in the great square may be seen, and the paper be laid upon the great square; the sum of all the 16 numbers, seen through the hole, is always equal to 2056, the sum of the 16 numbers in any horizontal or vertical column.

MAGISTERY, an old chemical term, very nearly synonymous with precipitate, but is now rarely used, except in the following combinations: magistery of bismuth, which is the white oxide of this metal precipitated from the nitrous solution by the addition of water; magistery of sulphur, which is sulphur precipitated from its alkaline solution by an acid.

MAGNA *charta*. See LIBERTY.

MAGNESIA, in chemistry, an earth, the properties of which were not fully known till Dr. Black, about the middle of the last century, investigated its nature. In the pursuit, the Doctor was led to the important discovery of the carbonic acid gas. Magnesia had, before his time, been frequently confounded with lime; he, however, by the most accurate experiments shewed that it possessed properties different from all the other earths. Although magnesia exists in great abundance in combination with other substances, it has never been found perfectly pure in nature. It is an ingredient in many fossils; and several of the salts, which it forms by combination with the acids, are found in mineral springs, and in the water of the ocean. From these combinations magnesia is obtained by different artificial processes. Mr. Murray mentions the sulphate of magnesia, or Epsom salt, as well adapted to this purpose. One part of this salt is to be dissolved in twenty of water, and the solution filtered; to this is added, while hot, a solution of pure potash or soda, as long as precipitation is produced. The alkali combines with the sulphuric acid, and the magnesia is separated: being insoluble in water, it falls down in white powder: it is then washed in water till the fluid comes off tasteless. This earth exists under the form of a white spongy powder, soft to the touch, without smell, and having a slightly bitter taste. Its specific gravity is 2.3. It slightly changes vegetable colours to a green. Magnesia, when quite pure, is infusible, though exposed to the most intense heat: even in the focus of the very powerful burning mirror, or in the heat excited by oxygen gas, it cannot be melted. When made into a paste with water it contracts like alumina, if exposed to a sudden heat. It is almost insoluble in water. There is no action between magnesia and hydrogen, or carbon, and very little between it and phosphorus. It combines readily with the acids, and with them forms neutral salts. Of these the greater number are soluble or crystallizible, and have a bitter taste. It does not enter into combination with the fixed alkalies, but in combination with some of the other earths, it is fusible by means of a very strong heat. With lime, in certain proportions, it forms a greenish yellow glass. It is much used in medicine as a gentle laxative, and as an absorbent to destroy acidity in the stomach. It is also employed to aid the solution of resinous and gummy substances, as camphor and opium in water. We shall notice only a few of its combinations.

Magnesia combines with sulphur either in the dry or humid way, forming thereby a sulphuret of magnesia. The solid sulphuret of magnesia decomposes rapidly when exposed to the air.

Sulphate of magnesia is a compound of sulphuric acid and magnesia, and is found in sea water, and in many mineral springs. Those at Epsom once afforded a large part of what was used in commerce; hence the name of Epsom salt. Now indeed it is commonly obtained from sea-water. The bittern water, or, as it is usually called, the mother water of common salt, that is, the water which remains after the crystallization, consists chiefly of sulphate of magnesia. The constituent parts are, according to Bergman,

Sulphuric acid	33
Magnesia	19
Water	48
	100

But Mr. Kirwan gives a different result.

	In crystals.	Dry.
Sulphuric acid . .	29.35	63.32
Magnesia	17.00	36.68
Water	53.65	
	100	100

Sulphate of magnesia is formed by passing sulphurous acid through water, in which magnesia is diffused. At first it is in a state of powder, which is gradually dissolved, and by exposure to the air, it deposits crystals, and passes into sulphate of magnesia. It consists of

Sulphurous acid	39
Magnesia	16
Water	45
	100

Carbonate of magnesia, or the magnesia alba, of the physicians, is a very important compound. The manufacture of this on the large scale is thus conducted. Instead of the pure sulphate of magnesia, the bittern, or liquor remaining after the crystallization of sea salt is used, and the magnesia is precipitated by carbonate of potash. When properly prepared it is perfectly white, nearly or wholly tasteless, and very sparingly soluble in water. The magnesia of commerce is composed of

	Fourcroy.	Kirwan.
Carbonic acid	48	34
Magnesia	40	45
Water	12	21
	100	100

When common carbonate of magnesia is exposed to a moderate heat, it is decomposed: its carbonic acid disengaged. It loses about half its weight, and the magnesia remains nearly pure.

Under the magnesian genus of fossils are comprehended, not only those in which magnesia is the ingredient which is present in largest proportion, but those also in which, though in a smaller proportion, there exist the characters in some measure peculiar to this genus. These are softness, unctuosity, and being in general destitute of hardness, lustre, and transparency, which are conspicuous in many of those which belong to the silicious and argillaceous genera. Magnesian fossils have usually a green colour, more or less deep.

MAGNET. See MAGNETISM.

MAGNETISM, is supposed to have been first rendered useful about the end of the twelfth, or at least very early in the thirteenth century, by John de Gioja, a handicraft of Naples, who noticed the peculiar attraction of metals, iron in particular, towards certain masses of rude ore; the touch of which communicated to other substances of a ferruginous nature, especially iron or steel bars, the same property of attraction: these touched bars he observed to have a peculiar and similar tendency towards one particular point; that when suspended in equilibrio, by means of threads around their centres, they invariably indicated the same point; and that, when placed in a row, however adversely directed, they soon disposed themselves in perfectly parallel order. In this instance, he improved upon the property long known to, but not comprehended or applied to use by the ancients, who considered the loadstone simply as a rude species of iron ore, and curious only so far as it might serve to amuse. Gioja being possessed of a quick understanding, and of a strong mind, was not long in further ascertaining the more sensible purposes to which the magnet might be appropriated. He accordingly fixed various magnets upon pivots, supporting their centres in such manner as allowed the bars to traverse freely. Finding that, however situated within the reach of observation and comparison, they all had the same tendency, he naturally concluded them to be governed by some attraction, which might be ultimately ascertained and acted upon. He therefore removed into various parts of Italy, to satisfy himself whether or not the extraordinary impulse which agitated these bars that had been magnetised by friction, existed only in the vicinity of Naples, or was general. The result of his researches appears to be, that the influence was general, but that the magnets were rendered extremely variable, and fluctuated much, when near large masses of iron. The experiments of Gioja gave birth to many others, and at length to a trial of the magnetic influence on the surface of the water. To establish this, a vessel was moored out at sea, in a direction corresponding with that of the magnet; and a boat, having a magnet equipoised on a pivot at its cen-

tre, was sent out at night in the exact line indicated thereby; which, being duly followed, carried them close to the vessel that was at anchor. Thus the active power of attraction appeared to be established on both elements, and in the course of time the magnet was fixed to a card, marked with thirty-two points, whereby the mariner's compass was presented to us. The points to which the magnet always turned itself, being generally in correspondence with the meridian of the place where it acted, occasioned the extremities of the bars to be called poles. Succeeding experiments proved, that the magnetic bar never retained an exactly horizontal position; but that one of its poles invariably formed an angle with any perfect level, over which it was placed: this was not so very measurable in a short bar, but in one of a yard in length was found to give several degrees of inclination. This, which is called "The Dip of the Needle," (or magnet) seems to indicate that the attracting power is placed within the earth. What that attracting power is we cannot determine; some consider it to be a fluid, while others conjecture it to be an immense mass of load-stone situated somewhere about the north pole. The difficulty is, however, considerably increased by the known fact of the needles of compasses not always pointing due north; but in many places varying greatly from the meridional lines respectively; and from each other at different times and places. The facility with which a meridional line may be drawn by solar observation, and especially by taking an azimuth, fortunately enables navigators to establish the variation between the true northern direction, and that indicated by the magnet attached to the card of the compass. Nevertheless, we have great reason to believe, that, for want either of accurate knowledge of the prevalent variations, or from inattention thereto, many vessels, of which no tidings were ever heard, have been cast away; it being obvious that a false indication of the northern point, in many places amounting to nearly the extent of twenty-five degrees, must produce so important an error in a vessel's course, as to subject her to destruction on those very shoals, rocks, &c. which the navigator unhappily thinks he steers wide of. To obviate such danger, as far as possible, all modern sea-charts have the variations of the compass in their several parts duly noted down; and in reckoning upon the course steered by compass, an allowance is usually made for the difference between the apparent course, by the compass, and the real course, as ascertained by celestial observation. Under circumstances so completely contradictory, the principle of magnetism must remain unknown: we know not of any hypothesis which strikes conviction on our minds, or which seems to convey any adequate idea of the origin, or *modus operandi*, of this wondrous influence. All we can treat of is the effect; also of the appearances which guide our practice, and of the manner in which the attractive power may be generated and increased.

In regard to the latter point, namely, the generation and increase of the magnetic attraction, we shall endeavour to give a brief but distinct view of what relates thereto; observing, that where volcanic eruptions are frequent, and in those latitudes where the aurora borealis is distinctly seen, the needle or magnet is sensibly affected. Previously to earthquakes, as well as during their action, and while the northern lights are in full display, no reliance can be placed on the compass; of which the card will appear much agitated. This has given rise to the opinion held by some, that the power is a fluid: to this, however, there appear so many objections, that we are more disposed to reject than to favour it, although under the necessity of confessing that we are not able to offer one that may account satisfactorily for the various phenomena attendant upon magnetism.

We have already stated, that every magnet has two poles; that is, one end is called the north, the other the south, pole: the former being considered as capable of attraction; the other, as we shall infer from the subjoined explanations, being far more inert, if at all possessed of an attractive power. When two magnets are brought together with their north poles in contact, they will, instead of cohering, be obviously repelled to a distance corresponding with their respective powers of attraction, when applied individually to unmagnetised needles. The south poles will, in like manner, repel each other; but the north pole of one, and the south pole of the other, will, when approximated, be evidently attracted, and will cohere so as to sustain considerable weights. Iron is the only metal, hitherto known, which is capable of receiving and communicating the magnetic power; but quiet, and the absence of contact, in some respects, are indispensably necessary towards its perfect retention. Thus, when a bar has been im-

pregnated, however abundantly, with the magnetic principle, if it be heated or hammered, the power of attraction will be dissipated; or if a tube filled with iron filings have their surface magnetised, by shaking the tube the magnetic influence will likewise be lost. In some respects, the magnetic influence resembles caloric; for it very rapidly communicates to iron, devoid of magnetism, a certain portion of its own powers; which, however, appear to be reproduced instantaneously. As various small fires under one large vessel will thereby heat it, and cause the water it contains to boil, though either of them individually would not produce that effect; so many weak magnets may, by causing each to communicate a power equal to its own, be made to create an accumulated power, larger than that contained by either of them individually: there is, however, a seeming contradiction to be found in some authors, who recommend that the weakest magnets should be first applied, and those more forcible in succession, according to the power they may possess; the reason assigned being, that the weaker magnets would else, in all probability, draw off some of the accumulated power from the new magnet. Of this there appears no danger, since experience proves that magnets rather gain than lose efficiency by contact, not only with each other, but even with common iron. In fact, the magnetic power may at any time be created by various means: the friction of two pieces of flat and polished bars of iron will cause them for a short while to attract, and to suspend, light weights. Soft iron is more easily influenced, but steel will retain the influence longer. Lightning, electricity, and galvanism, being all of the same nature, equally render iron magnetic. It is also peculiar, that when two or more magnets are left for any time with their several north poles in contact, the whole will be thereby weakened; whereas, by leaving a piece of common iron attached to a magnet, the latter will acquire strength. It is also well known, that some pieces of steel quickly receive the magnetic influence, while others require considerable labour, and after all are scarcely impregnated. The oxide of iron cannot be impregnated, and those bars that have been so, when they become partially oxydized, lose their power. Hence we see the necessity of preserving the needles of compasses from rust.

Magnets have the power to act, notwithstanding the intervention of substances in any degree porous between them, and the body to be acted upon: thus, if a needle be put on a sheet of paper, and a magnet be drawn under it, the needle will follow the course of the magnet. The peculiar affinity of the load-stone for iron is employed, with great success, by those who work in precious metals, for the separation of filings, &c. of iron from the smaller particles of gold, &c. A magnet being dipped into the vessel, in which the whole are blended, will attract all ferruginous particles.

To communicate the magnetic power to a needle, let it be placed horizontally, and with a magnet in each hand, let the north pole of one, and the south pole of the other be brought, obliquely, in contact over the centre of the needle; draw them asunder, taking care to press firmly, and preserving the same angle or inclination to the very ends of the needles, which should be supported by two magnets, whose ends ought to correspond in polarity with those of the needle. Observe to carry the magnets you press with clear away from the ends of the needle, at least a foot therefrom; repeat the friction in the same manner several times, perhaps six, eight, or ten times, and the needle will be permanently magnetized. As we have already stated, by using other magnets in succession, the powers of the needle will be proportionably increased. But no effect will result from the friction if the bars are rusty, or, indeed, not highly polished; their angles must be perfect, and their several sides and ends completely flat.

It is, perhaps, one of the most curious of the phenomena attendant upon this occult property, that the centre of every magnet is devoid of attraction; yet, that when a needle is placed in a line with a magnet, and within the influence of its pole, that needle also becomes magnetic; or, rather, a conductor, possessing a certain portion of attractive power: and it is no less extraordinary, that the magnet retains its power even in the exhausted receiver of an air-pump: this seems to be a formidable objection to its being influenced by any fluid. Perhaps the opinion entertained by many of our most popular lecturers on this subject, *viz.* that the earth itself is the great attractor, may be nearest the truth. We are the more supposed to incline towards such an hypothesis, knowing that, at the true magnetic equator, the needle does not dip; and from the well ascertained fact, that bars of iron, placed for a length of time exactly

perpendicular, receive a strong magnetic power, their lower ends repelling the south, but attracting the north poles of magnets applied to them respectively. The direction of the dipping needle was ascertained by one Robert Norman, about two hundred and fifty years ago. He suspended a small magnetic needle, by means of a fine thread around its centre, so as to balance perfectly, over a large magnet: the south pole of the former was instantly attracted by the north pole of the latter. He found that so long as the needle was held exactly centrical, at about two inches above the magnet, it remained horizontal: but so soon as withdrawn a little more towards one end than the other of the magnet, the equilibrium was destroyed, and that pole of the needle which was nearest to either pole of the magnet was instantly attracted, and pointed downwards thereto. By the magnetic equator, we mean a circle passing round the earth at right angles with the magnetic poles, which do not correspond with the geographical poles, as may be fully understood by the indications of all compasses to points differing from the latter; and as the indications of compasses vary so much, both at different times and places, we may reasonably conclude, that the magnetic poles are not fixed. The variation of the dipping needle has not, in our latitude at least, varied more than half a degree since its depressive tendency was first discovered by Norman.

The suspension of Mahomet's body, in the temple where it was deposited, is supposed to have resulted entirely from magnetism, with which the Arabians were completely unacquainted.

MAGNETISM, *animal.* About thirty years ago, Father Hehl, of Vienna, imposed on his countrymen, and indeed on the greater part of the civilized world, a pretended mode of curing all kinds of disease, by means of a sympathetic affection between the sick person and the operator. The remedy was supposed to depend upon the motions of the fingers, and the features of the latter, he placing himself immediately before the invalid, whose eyes were to be fixed on his, and performing a number of antic and unmeaning changes, accompanied by various grimaces, or inflections of the principal muscles of the visage. This rarely failed to excite a certain degree of apprehension in the mind of the sick; which, by creating a new action of the system, often frightened them into convalescence. That such effects may have been produced among the credulous and timid, we shall not controvert; but, on the other hand, it is asserted, that numbers have been so far overcome with terror and fatigue, (for, like Dr. Sangrado, the operator was never satisfied while any strength to undergo the process remained) that consequences highly dangerous, and in some instances fatal, were induced. Notwithstanding the obvious folly of the pursuit, there were found many gentlemen of great respectability and talents among its followers; hence a certain degree of credit was established, and there were not wanting persons foolish enough to certify many cases, and to give a celebrity, which was in a very short time found to be misapplied. It is a lamentable case, that, throughout the world, impositions of this nature are always tolerated long enough to answer the purposes of the fabricator, and to encourage others in similar deceptions. Our readers may recollect many instances of notorious character, among which the metallic-tractors, which were at one time asserted to be allied to metallic-magnetism, may, perhaps, serve as a proper illustration and proof.

MAGNIFYING, in philosophy, the making of objects appear larger than they would otherwise do; whence convex lenses, which have the power of doing this, are called magnifying glasses; and of such glasses are microscopes constructed.

MAGNITUDE, whatever is made up of parts locally extended, or that hath several dimensions; as a line, surface, solid. The apparent magnitude of a body is that measured by the visual angle, formed by rays drawn from its extremes to the centre of the eye; so that whatever things are seen under the same or equal angles, appear equal; and *vice versa.* Mr. Maclaurin observes, that geometrical magnitudes may be usefully considered as generated or produced by motion. Thus, lines may be conceived as generated by the motion of points; surfaces, by the motion of lines; solids, by the motion of surfaces; angles may be supposed to be generated by the rotation of their sides. Geometrical magnitude is always understood to consist of parts; and to have no parts, or to have no magnitude, are considered as equivalent in this science. There is, however, no necessity for considering magnitude as made up of an infinite number of small parts; it is sufficient that no quantity can be supposed to be so small,

but it may be conceived to be farther diminished: and it is obvious, that we are not to estimate the number of parts that may be conceived in a given magnitude, by those which, in particular determinate circumstances, may be actually perceived in it by sense, since a greater number of parts become sensible, by varying the circumstances in which it is perceived.

MAGNOLIA, in botany, so named in honour of Pierre Magnol, professor of medicine, and prefect of the botanic garden at Montpelier, a genus of the Polyandria Polygynia class and order. Natural order of Coadunatæ. Magnoliæ, Jussieu. Essential character: calyx three-leaved; petals nine: capsule one-celled, two-valved; seeds berried, pendulous, There are seven species; of which M. grandiflora, great laurel-leaved magnolia, or tulip tree, in the southern provinces of North America, grows to the height of eighty feet: the trunk is more than two feet in diameter; the leaves are nine or ten inches long, and three broad in the middle, of a thick consistence, resembling those of the common laurel, but much larger; of a lucid green, sessile, and placed without order on every side of the branches; continuing green all the year, falling off only as the branches extend, and the new leaves are produced. The flowers come out at the ends of the branches: they are large, and composed of eight or ten petals, which are narrow at the base, broad, rounded, and a little waved at their extremities; they are of a pure white colour, possessing an agreeable scent. The summers in England are not warm enough to bring the fruit to perfection. This fine tree is a native of Florida and Carolina, and, in common with many of the trees and plants of that country, is impatient of cold here, and difficult to keep in perfection, either abroad or housed.

MAHERNIA, in botany, a genus of the Pentandria Pentagynia class and order. Natural order of Columniferæ. Tiliaceæ, Jussieu. Essential character: calyx five-toothed; petals five; nectaries five, obcordate, placed under the filaments; capsule five-celled. There are three species, natives of the Cape of Good Hope.

MAHOGANY. The swietenia mahagoni, or mahogany tree, is a native of the warmest parts of America, and grows also in the island of Cuba, Jamaica, Hispaniola, and the Bahama islands. It abounded formerly in the low lands of Jamaica; but it is now found only on hills, and places difficult of access. This tree grows tall and straight, rising often sixty feet from the spur to the limbs; and is about four feet in diameter. The foliage is a beautiful deep green, and the appearance made by the whole tree very elegant. The flowers are of a reddish or saffron colour, and the fruit of an oval form, about the size of a turkey's egg. Some of them have reached to a monstrous size, exceeding one hundred feet in height. In felling these trees, the most beautiful part is commonly left behind. The negro workmen raise a scaffolding of four or five feet elevation from the ground, and hack up the trunk, which they cut into balks. The part below, extending to the root, is not only of larger diameter, but of a closer texture than the other parts, most elegantly diversified with shades or clouds, or dotted like ermine with spots: it takes the highest polish, with a singular lustre. This part is only to be come at by digging below the spur, to the depth of two or three feet, and cutting it through; which is so laborious an operation, that few attempt it, except they are curious in the choice of their wood, or to serve a particular purpose. The mahogany tree thrives in most soils; but varies in texture and grain, according to the nature of the soil. On rocks it is of a smaller size; but very hard and weighty, and of a close grain, and beautifully shaded; while the produce of the low and richer lands is observed to be more light and porous, of a paler colour, and open grain; and that of mixed soils to hold a medium between both. This constitutes the difference between the Jamaica wood and that which is collected from the coast of Cuba and the Spanish Main; the former is mostly found on rocky eminences; the latter is cut in swampy soils, near the sea coast. The superior value of the Jamaica wood, for beauty of colouring, firmness, and durability, may therefore be easily accounted for; and a large quantity of balks and planks is brought from the Spanish American coasts to Jamaica, to be shipped from thence to Great Britain. This wood is generally hard, takes a fine polish, and is found to answer better than any other sort in all kinds of cabinet ware. It is a very strong timber, and was frequently used as such in Jamaica in former times. It is said to be used sometimes in ship-building; a purpose for which it would be remarkably adapted, if not too costly; being very durable, capable of resisting gun-shots, and burying the shots without splintering.

MAHOMETANS, believers in the doctrines and divine mission of Mahomet, the celebrated warrior and pseudo-propbet of Arabia, who was born at Mecca in the year 571. The father of Mahomet was Abdollech, descended from the Korashites, tribes who had long enjoyed the regal dignity in Arabia. Notwithstanding the royal descent of the prophet, it appears that a variety of adverse circumstances concurred to render him, in the early part of his life, indigent and obscure. His father died before he was two years of age, and his mother when he was about eight; so that he was left in a manner destitute of subsistence, and his education, in a great measure, if not altogether, neglected. After the death of his mother, he was committed to the care of his grandfather, who dying within a year afterwards, he was taken under the protection of his uncle Taleb, a merchant of some respectability. There are various accounts relative to the manner in which Mahomet first began to invent and propagate his new system of faith and worship. It appears, according to the Mahometan historians, that his pretended mission was revealed to him in a dream, in the fortieth year of his age. From that time, say his biographers, Mahomet, under the influence of a holy terror, devoted himself to a solitary life. He retired to a grotto in the mountain of Hira, which overlooks Mecca. He there passed his days and nights in fasting, prayer, and meditation. In the midst of one of these profound ecstasies, the angel Gabriel appeared to him, with the first chapter of the Koran, and commanded him to read. Mahomet replied, he was unable; upon which the angel repeatedly embraced him, and commanded him to read, in the name of his Creator. A few days after, praying upon the same mountain of Hira, Mahomet again saw the angel of the Lord, seated in the midst of the clouds on a glittering throne, with the second chapter of the Koran; and was addressed by him in the following words: "O thou who art covered with a celestial mantle, arise and preach!" Thus the angel Gabriel communicated, by command of the Eternal, to his prophet, in the twenty-three last years of his life, the whole book of the Koran, leaf by leaf, chapter by chapter. There are, however, different accounts respecting the portions or parcels in which the Koran was given to Mahomet. See ALCORAN.

During the first thirteen years of the prophet's mission, he appears to have made very slow progress; but the last ten were employed with greater success. Finding that visions, ecstasies, revelations, and arguments, did not succeed so rapidly as he could have wished in making proselytes, he determined to try the more powerful and adventurous inducements of coercion. After his flight from Mecca to Medina, which took place A. D. 622, and from which his followers compute their time, the prophet made rapid progress. Thousands flocked to his standard, and he soon convinced his enemies, that if they refused to admit the divinity of his mission, they should feel the weight of his arm. He declared, that God sent him into the world, not only to teach his will, but to compel mankind to embrace it. "The word," said he, "is the key of heaven and hell; a drop of blood shed in the cause of God, or a night spent in arms, is of more avail than two months of fasting and prayer. Whosoever falls in battle, his sins are forgiven at the day of judgment; his wounds shall be resplendent as vermilion, and odoriferous as musk, the loss of his limbs shall be supplied by the wings of angels and cherubim." Who would not die to be acquitted at the bar of heaven? Who would not prefer a night in arms to a fast of two months? And what mortal but would prefer the odours of musk to the stench of plasters or fœtid ointments; the wings of angels to the cumbrous appendages of human limbs? These representations were attended with the desired effect on the minds and conduct of the prophet's admirers. They assembled in numbers to fight for God and his prophet. Headed by a chieftain of invincible courage, attractive eloquence, and astonishing genius, guarded by angels (as they supposed), and enflamed by the holy fire of fanaticism, success attended almost all their engagements. Mahomet, thus elevated, formed the stupendous design of creating a new empire. Here again success crowned his efforts. His plan was executed with such intrepidity, that be died, A. D. 632, master of all Arabia, besides several adjacent provinces. It is not our business, nor will our limits admit of it, to account for the rapid progress of the Mahometan faith. We may, however, summarily state, as causes of the eastern prophet's success: the terror of his arms; the artful nature of his law, which offered such rewards to the faithful, and such punishments to the infidels, as were best suited to the luxuriant fancies of the Arabians; the

plainness and simplicity of some of his doctrines; the adaptation of the duties which his law enjoined to the passions and appetites of mankind; the profound ignorance under which the Arabians, Syrians, Persians, and the greatest part of the eastern nations, then laboured; and, lastly, the dissensions and animosities that then ravaged the peace, and destroyed the union of the Christian sects, particularly the Greeks, Nestorians, Eutychians, and Monophysites, and which rendered the very name of Christianity odious to many. These are some of the causes which gave life and strength to the Mahometan religion in the east.

The religion of Mahomet is divided into two general parts: faith and practice. The fundamental article of the Mahometan creed is contained in this confession: THERE IS BUT ONE GOD, AND MAHOMET IS HIS PROPHET. Under these two propositions are comprehended six distinct branches: *viz.* belief in God; in his angels; in his scriptures; in his prophets; in the resurrection and judgment; and in God's absolute decrees, or predestination. They reckon five points relating to practice: *viz.* prayer with washings, &c.; alms; fasting; pilgrimage to Mecca; and circumcision. Mahomet admitted the divine mission of both Moses and of Jesus Christ. Dr. Jortin says, that Mahometism is a borrowed system, made up for the most part of Judaism and Christianity; and if it be considered, the the same writer observes, in the most favourable point of view, might possibly be accounted a sort of Christian heresy. Achmet Benabdalla, in his letter to Maurice, Prince of Orange, says, "The Lord Jesus Christ is held by us (Mahometans) to be a prophet, and the messenger of God, and our lady, the virgin Mary, his mother, to be blessed of God, holy, who brought him forth, and conceived him miraculously by the almighty power of God."

The Mahometans are a superstitious people, and hence in their religion we find a prodigious number of rites, ceremonies, and observances; the principal of which are: circumcision, ablutions, fastings, pilgrimage, polygamy, marriage rites, mourning for the dead, funeral rites, and the observance of Friday as a Sabbath. In all these observances, &c. there is a mixture of Heathenism, Judaism, and Christianity. After the death of their prophet, the Mahometans were divided, like the Christians, into an incredible number of sects and parties, all of them, however, professing to adhere to the Koran as the rule and guide of their faith and practice, yet differing widely from each other in particular points of belief, relative to doctrine, practice, and ecclesiastical discipline. Those who wish to see the history and character of this extensive sect more particularly detailed, will do well to consult the following authors: Fabricius's "Delectus et Syllabus argument. pro veritate relig. Christianæ;" Boulainvillier's, Gagnier's and Prideaux's Lives of Mahomet; Sale's English Translation of the Koran; to which may be added, Professor White's Sermons at the Bampton Lectures, and Millar's account of Mahomet in his "Propagation of Christianity," vol. i. c. 1.

MAIDEN, in ancient English customs, an instrument for beheading criminals. Of the use and form of this instrument Mr. Pennant gives the following account: "It seems to have been confined to the limits of the forest of Hardwick, or the eighteen towns and hamlets within its precincts. The time when this custom took place is unknown; whether Earl Warren, lord of this forest, might have established it among the sanguinary laws then in use against the invaders of the hunting rights, or whether it might not take place after the woollen manufacturers at Halifax began to gain strength, is uncertain. The last is very probable; for the wild country around the town was inhabited by a lawless set, whose depredations on the cloth-tenters might soon stifle the efforts of infant industry. For the protection of trade, and for the greater terror of offenders by speedy execution, this custom seems to have been established, so as at last to receive the force of law, which was, 'That if a felon be taken within the liberty of the forest of Hardwick, with goods stolen out, or within the said precincts, either hand-habend, back-berand, or confession'd, to the value of thirteen pence half-penny, he shall, after three market days, or meeting days, within the town of Halifax, next after such his apprehension, and being condemned, be taken to the gibbet, and there have his head cut from his body.' The offender had always a fair trial: for as soon as he was taken, he was brought to the lord's bailiff at Halifax: he was then exposed on the three markets (which here were held thrice in a week), placed in the stocks, with the goods stolen on his back, or, if the theft was of the cattle kind, they were placed by him; and this was done both to strike

terror into others, and to produce new informations against him. The bailiff then summoned four freeholders of each town within the forest to form a jury. The felon and prosecutors were brought face to face; and the goods, the cow or horse, or whatsoever was stolen, produced. If he was found guilty he was remanded to prison, had a week's time allowed for preparation, and then was conveyed to this spot, where his head was struck off by this machine. I should have premised, that if the criminal, either after apprehension, or in the way to execution, should escape out of the limits of the forest (part being close to the town,), the bailiff had no further power over him; but if he should be caught within the precincts at any time after, he was immediately executed on his former sentence.

"This privilege was very freely used during the reign of Elizabeth: the records before that time were lost. Twenty-five suffered in her reign, and at least twelve from 1623 to 1650; after which, I believe, the privilege was no more exerted.

"This machine of death is now destroyed; but I saw one of the same kind in a room under the parliament house at Edinburgh, where it was introduced by the regent Morton, who took a model of it as he passed through Halifax, and at length suffered by it himself. It is in form of a painter's easel, and about ten feet high: at four feet from the bottom is a cross bar, on which the felon lays his head, which is kept down by another placed above. In the inner edges of the frame are grooves; in these is placed a sharp axe, with a vast weight of lead, supported at the very summit with a peg: to that peg is fastened a cord, which the executioner cutting, the axe falls, and does the affair effectually, without suffering the unhappy criminal to undergo a repetition of strokes, as has been the case in the common method. I must add, that if the sufferer is condemned for stealing a horse or a cow, the string is tied to the beast, which, on being whipped, pulls out the peg, and becomes the executioner." This apparatus is now in possession of the Scottish Antiquarian Society.

MAJESTY, a title given to kings, which frequently serves as a term of distinction.

MAIHEM, or Maim, signifies a corporal wound or hurt by which a man loseth the use of any member.

By the old common law, castration was punished with death, and other members with the loss of member for member; but of latter days, maihem was punishable only by fine and imprisonment. If a man attack another with an intent to murder him, and he does not murder the man, but only maim him, the offence is nevertheless a capital felony within the statute 22 and 23 Charles II. c. 1, usually called the Coventry Act.

And by a late statute, 44 Geo. III. c. 58, if any person shall, either in England or Ireland, wilfully, maliciously, and unlawfully, shoot at any of his Majesty's subjects, or wilfully, maliciously, and unlawfully present any kind of loaded fire-arms at any one, and attempt to discharge the same at him, or wilfully, maliciously, and unlawfully stab or cut any of his Majesty's subjects, with intent in so doing, or by means thereof to murder or rob, or to maim, disfigure, or disable him, or with intent to do some other grievous bodily harm to him, or to obstruct, resist, or prevent the lawful apprehension and detainer of the person so stabbing or cutting, or of any of his accomplices, for any offence for which they may be liable to be detained, or shall wilfully, &c. administer poison with intent to murder, or to procure the miscarriage of any woman quick with child, he shall be guilty of felony, and suffer death. But in case of levelling fire-arms, or cutting and maiming as aforesaid, if it shall appear that if death had ensued, the party would not have been guilty of murder, then the defendant shall be acquitted.

A person who maims himself that he may have the more colour to beg, or that he may not be impressed, may be indicted and fined.

MAINPRIZE, a delivering a person to his friends, to be answerable for his appearance. It differs from bail, as the mainpernors cannot keep the party in custody, but must let him be at liberty till the day of his appearance.

MAINTENANCE, the unlawful taking in hand or upholding a cause of any person. It was formerly unlawful to assist any person in litigation, except as an attorney, advocate, kinsman, servant, or near relation, out of charity. The late Judge Buller expressed serious doubts whether the law against maintenance was not obsolete.

MAJOR, in the art of war, the name of several officers of very different ranks and functions; as, 1. Major-general, the next officer to the lieutenant-general: his chief business is to receive the orders from the general, or in his absence from the lieutenant-general of the day; which he is to distribute to the brigade-majors,

with whom he is to regulate the guards, convoys, and detachments. When there are two attacks at a siege, he commands that on the left. He ought to be well acquainted with the strength of each brigade, of each regiment in particular, and to have a list of all the field officers. In short, he is in the army, what a major is in a regiment. He is allowed an aid-de-camp, and has a serjeant and fifteen men for his guard. 2. Major of a brigade, the officer who receives the orders from the major-general, and afterwards delivers them to the adjutants of the regiments at the head of the brigade; where he takes and marches the detachments, &c. to the general rendezvous. He ought to be an expert captain, to know the state and condition of the brigade, and keep a roll of the colonels, lieutenant-colonels, majors, and adjutants. 3. Major of a regiment, the next officer to the lieutenant-colonel, generally promoted from the oldest captain. He is to take care that the regiment be well exercised, to see it march in good order, and to rally it in case of its being broke. He is the only officer among the foot that is allowed to be on horseback in time of action, that he may the more readily execute the colonel's orders, either in advancing or drawing off the regiment. 4. Major of a regiment of horse, is the first captain, who commands in the absence of the colonel. 5. Town-major, the third officer in a garrison, being next to the deputy-governor. He ought to understand fortification, and hath charge of the guards, rounds, patroles, &c. His business is also to take care that the soldiers' arms are in good order: he likewise orders the gates to be opened and shut, and gives the governor an account of all that passes within the place.

There are also drum-majors, &c. so called from their pre-eminence above others of the same denomination.

MAKING *up*, among distillers, the reducing spirits to a certain standard of strength, usually called proof, by the admixture of water; which should be either soft and clear river water, or spring water rendered soft by distillation.

MALACHITE, a mineral, the green carbonate of copper, found frequently crystallized in long slender needles; colour green, and the specific gravity about 3.6. It effervesces with nitric acid, and gives a blue colour to ammonia. It decrepitates and blackens before the blow-pipe. There are two varieties, the fibrous and the compact: the constituent parts are,

Copper	58.0
Carbonic acid	18.0
Oxygen	12.5
Water	11.5
	100.0

MALACHRA, in botany, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx common three-leaved, many-flowered, larger; arils five, one-seeded. There are five species, natives of America.

MALACHODENDRUM, in botany, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx simple; germ pear-shaped, pentagonal; styles five; capsule five, one-seeded. There are two species, *viz.* M. ovatum, and M. corchoroides.

MALACOLITE, a mineral found in the silver mines in Sweden, and also in Norway. It is obtained massive and crystallized in six-sided prisms. Specific gravity about 3.25. It consists of

Silica	53
Lime	20
Magnesia	19
Alumina	3
Oxide of iron, &c.	4
	99
Loss	1
	100

MALATES, in chemistry, salts formed by the union of the malic acid with different bases. These salts have not been fully investigated; but it has been ascertained that the malates of lime, barytes, and magnesia, are very insoluble. The malates of potash, soda, and ammonia, are deliquescent. The malates of potash, soda, ammonia, lime, and barytes, may be formed by dissolving these alkalies in malic acid, and evaporating the solutions.

MALAXIS, in botany, a genus of the Gynandria Diandria class and order. Natural order of Orchideæ. Essential character: nectary one-leafed, concave, cordate, acuminate backwards, bifid in front, cherishing the gentials in the middle. There are two species, *viz.* M. spicata,

and M. umbelliflora, both natives of Jamaica.

MALE, among zoologists, that sex of animals which has the parts of generation without the body.

The term male has also, from some similitude to that sex in animals, been applied to several inanimate things: thus we say, a male-flower, a male-screw, &c.

MALIC *acid*, in chemistry, was discovered by Scheele about the year 1785. It is found in the juices of a great many fruits, and it derives its name from the circumstance of its being obtained in great abundance from the juice of apples, in which it exists ready formed. It is thus obtained: saturate the juice of apples with potash, and add to the solution acetate of lead till no more precipitation ensues. Wash the precipitate carefully with a sufficient quantity of water; then pour upon it diluted sulphuric acid till the mixture has a perfectly acid taste, without any of that sweetness which is perceptible as long as any lead remains dissolved in it; then separate the sulphate of lead, which has precipitated, by filtration, and there remains behind pure malic acid. The French chemists have ascertained that it may be obtained in the largest quantities from the juice of the sempervivum tectorum, where it exists abundantly combined with lime. Malic acid is very soluble in water, and decomposes spontaneously, by undergoing a kind of fermentation. It is composed of oxygen, hydrogen, and carbon. It combines with alkalies, earths, and metallic oxides, and forms Malates, which see above.

Dr. Thomson has shewn in what the citric and malic acids agree, and in what they differ. The citric acid shoots into crystals; but the malic will not crystallize. The citrate of lime is almost insoluble in boiling water, but the malate of lime is easily soluble in that liquid. Malic acid precipitates mercury, lead, and silver, from the nitrous acid, and likewise the solution of gold when diluted with water; whereas the citric acid does not alter any of these solutions.

MALICE, a formed design of doing mischief to another. Malice is of two kinds; express or implied. Malice express, in cases of homicide, is, where one with a deliberate intention, evidenced by external circumstances, kills another. This intention may appear by lying in wait, antecedent menaces, former grudges, and concerted schemes to do one some bodily harm. Malice implied is various; as where one voluntarily kills another without any provocation, or where one wilfully poisons another; in such cases, the law implies malice, though no particular enmity can be proved. See Homicide.

In this latter case, the act, if it is in itself necessarily injurious to another, implies malice. As to stab one is the best evidence of a design to injure him, because the act necessarily must injure him, and malice is but a design to injure; and if it really were an accidental injury, that must be shown from other circumstances which are generally to be proved on the part of the defendant. Malice being a design to injure, any injurious act implies malice, but in common speech it is more frequently applied to the continued workings of a long preconceived hatred and ill-will.

MALLEABLE, a property of metals, whereby they are capable of being extended under the hammer. See Ductility and Metal.

MALLET, a kind of large wooden hammer, used by artificers who work with a chissel, as sculptors, masons, and stone-cutters, whose mallets are commonly round; and by joiners, carpenters, &c. who work with square-headed mallets.

MALLEUS, in anatomy, a bone of the ear, so called from its resemblance to a mallet, and in which is observed the head, the neck and handle, which is joined to the membrane of the tympanum.

MALOPE, in botany, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx double, outer three-leaved; arils glomerate, one seeded. There are two species, *viz.* M. malacoides, and M. parviflora, the former has greatly the appearance of mallow, but differs from it in having the cells collected into a button, somewhat like a blackberry? the bunches spread, and lie almost flat upon the ground, extending a foot or more each way. The flowers are produced singly upon long axillary peduncles, they are in shape and colour like those of mallow. It is a native of the meadows of Tuscany and of Barbary.

MALPIGHIA, in botany, so named in honour of Marcello Malpighi, professor of medicine at Bologna, a genus of the Decandria Trigynia class and order. Natural order of Trihilatæ. Malpighiæ, Jus-

sieu. Essential character: calyx five-leaved, with melliferous pores on the outside at the base; petals five, roundish, with claws; berry one-celled, three-seeded. There are eighteen species, of which M. glabra, smooth-leaved Barbadoes cherry, usually grows to the height of sixteen or eighteen feet; leaves opposite, subsessile, acute, continuing all the year; flowers in axillary and terminating bunches; the pedicles have a single joint: calyx incurved with glands; petals subcordate; stigmas simple, with a little drop; fruit red, round, the size of a cherry. This tree grows plentifully in most of the islands in the West Indies; whether it is natural there or not is difficult to determine, for birds being fond of the fruit, they disperse the seeds every where in great abundance.

MALT, a term applied to grain which has been made to germinate artificially to a certain extent, after which the process is stopped by the application of heat. The barley is steeped in cold water for a period not less than forty hours, by which it increases in bulk and imbibes moisture, while at the same time a quantity of carbonic acid gas is emitted, and a part of the substance of the husk is dissolved. The weight of the barley is increased in the proportion of 147 to 100, and the bulk is increased about one-fifth. When it is sufficiently steeped, the water is drained off, and the barley thrown out of the cistern upon the malt floor, where it is formed into a rectangular heap, called the couch, sixteen inches deep. In this state it remains about twenty-six hours. It is then turned by means of wooden shovels, and diminished a little in depth: this operation is repeated twice or thrice a day, and the grain is spread thinner and thinner, till at last its depth does not exceed a few inches. On the couch it absorbs oxygen from the atmosphere, which it converts into carbonic acid; the temperature gradually increases, and in about four days the grain is ten degrees hotter than the surrounding atmosphere. The grain now becomes moist, and exhales an agreeable odour; this is called the sweating. A small portion of alcohol appears to be volatilized at this period of the process. The chief business of the maltster is to keep the temperature from becoming excessive, which is done by turning. The temperature may vary from fifty-five to sixty-two degrees. At the period of sweating, the roots of the grains begin to appear, which increase in length till checked by turning the malt. In one day after the sprouting of the roots, the rudiments of the future stem, called acrospire by the maltster, may be seen to lengthen, and it is now time to stop the process. As the acrospire shoots along the grain, the appearance of the kernel, or mealy part of the corn, undergoes a considerable change. The glutinous and mucilaginous matter is taken up and removed, the colour becomes white, and the texture is so loose that it crumbles to powder between the fingers. The object of malting is to produce this change: when it is accomplished, which takes place as soon as the acrospire has come nearly to the end of the seed, the process is stopped by drying the malt upon the kiln. The malt is then cleaned to separate the small roots, which are considered as injurious. Barley by malting generally increases two or three per cent. in bulk, and loses about one-fifth of its weight.

MALTA, *knights of.* See KNIGHT.

MALTHA, in chemistry, called also *sea-wax*, is a solid substance found on the Lake Baikal in Siberia. It is white, melts when heated, and on cooling assumes the consistence of white cerate. It readily dissolves in alcohol, and in other respects it possesses the characters of a solid volatile oil.

MALVA, in botany, *mallow*, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx double, outer three-leaved; capsules many, united in a depressed whorl, one-celled, one-seeded. There are thirty-four species, chiefly perennial herbaceous plants.

MAMALUKES, the name of a dynasty that reigned in Egypt. The Mamalukes were originally Turkish and Circassian slaves, bought of the Tartars by Melicsaleh, to the number of a thousand, whom he bred up to arms, and raised some to the principal offices of the empire. They killed Sultan Moadam, whom they succeeded.

Others say, that the Mamalukes were ordinarily chosen from among the Christian slaves, and that they were the same thing in a great measure with the Janissaries among the Turks. They never married; they first are said to have been brought from Circassia, and some have supposed that they began to reign about the year 869.

MAMMÆ, the breasts, in anatomy. See MAMMARY *gland.*

MAMMALIA, in natural history, the first class of animals in the Linnæan system: the animals in this class have lungs

that respire alternately; jaws incumbent, covered; teeth usually within; teats lactiferous; organs of sense, tongue, nostrils, eyes, ears, and papillæ of the skin; covering, hair, which is scanty in warm climates, and scarcely any on aquatics; supporters, four feet, except in aquatics; and in most a tail; walk on the earth and speak. Such is the Linnæan account. They suckle their young by means of lactiferous teats, and hence the name mammalia. In structure they resemble man; most of them are quadrupeds, and with man inhabit the surface of the earth: a few of them exist in the ocean. There are seven orders, the characters of which are taken from the number, situation, and structure of the teeth. The names of the orders are,

Belluæ,	Glires,
Bruta,	Pecora,
Cete,	Primates,
Feræ,	

which see.

MAMMARY *gland*, in anatomy, is a glandular substance situated in the breast, and secreting the milk.

This gland, surrounded by cellular and adipous substance, and covered by the common integuments, constitutes the breast. It lies on the anterior surface of the pectoralis major muscle.

In men, and in young girls, these bodies are small; they enlarge in the female subject very considerably at the time of puberty, assuming an hemispherical shape, and pretty firm consistence, which, however, is lost as the subject advances in years, particularly in women who have suckled many children.

The skin of the breasts is white, and soft to the touch, except in the middle, where there is a portion of a reddish brown colour, called the areola. From the centre of this the nipple projects, in the form of a cylindrical prominence, with a rounded end, similar in colour to the areola, and covered, like that part, by a more delicate continuation of the skin, which is somewhat wrinkled and irregular on its surface. Both the areola and nipple are furnished with numerous sebaceous glands, which may be clearly seen through the integuments. The matter which these secrete, preserves the parts from the excoriation which they would otherwise suffer from suckling. The mammary gland is composed of a vast congeries of small tubes, convoluted and accumulated on each other, and known by the technical names of tubuli lactiferi. These unite together, gradually forming larger and larger trunks, which approach from all sides towards the nipple. The trunks become very much contracted at the areola, and in this state pass through the nipple, to terminate on its surface by open orifices, about fifteen in number, whose size is about sufficient to admit a hog's bristle. This structure can only be shewn during the period of suckling.

The use of the milk secreted in these glands, as a nutriment for the young animal, is known to every body. It is singular that they should exist in the male, where they never perform any office whatever; at least, except in very rare instances, where a fluid of a milky nature has been poured out from them.

MAMMEA, in botany, a genus of the Polygamia Monoecia, or Dioecia class and order. Natural order of Guttiferæ, Jussieu. Essential character: calyx one-leafed, two-parted; corolla four-petalled; berry very large, four-seeded. There is but one species, *viz.* M. Americana, American mammee, which is a lofty, upright, handsome tree, with a thick spreading elegant head; it has a long tap root, which renders it difficult to transplant; the leaves are oval, quite entire, extremely shining, leathery, firm, with parallel transverse streaks, on short petioles from five to eight inches in length; peduncles one-flowered, scattered over the stouter branches; flowers sweet, white, an inch and half in diameter; the calyx is often trifid, with a five-petalled corolla. It is a native of the Caribbee islands, and the neighbouring continent.

MAN. The natural history of man is yet in its infancy; insomuch that we cannot pretend to give any thing like a complete view of the subject. The description and arrangement of the various productions of the globe, have occupied numerous observers in all ages of the world; and every insect and plant of common occurrence has been described with minute accuracy, while the human subject alone has been almost entirely neglected. It is only of late that the natural history of man has begun to receive its due share of attention; and we shall venture to assert, that, whether we regard the intrinsic importance of the questions that arise, or merely advert to the pleasure of the research, no subject will be found more deserving of minute investigation. Much of the following sketch is derived from Blumenbach, "De Generis Humani Varietate Nativa." Ed. 3d, Götting. 1795; to which we refer the reader for more

detailed information. He may also consult the "Decades Craniorum" of the same author; Camper, "Traité des Differences Reeles," &c. 4to.; Buffon, in his large work on "Natural History;" Hunter, "Disp. Inaug. de Hominum Varietatibus, earumque Causis;" Zimmerman, "Geographische Geschichte der Menschen, &c." and Ludwig, "Grundriss der Naturgeschichte der Menschen—species."

The differences which exist between inhabitants of different regions of the globe, both in bodily conformation and in the faculties of the mind, are so striking, that they must have attracted the notice even of superficial observers. There are two ways of explaining these: first, by referring the different races of men to different original families, according to which supposition they will form, in the language of naturalists, different species; or we may suppose them all to have descended from one family, and account for the diversity which is observable in them, by the influence of physical and moral causes; in which case they will only form different varieties of the same species.

Before, however, we enter upon this discussion, it will be necessary to dispose of a previous question, *viz.* what are the characters which distinguish man from all other animals; those which constitute him a distinct genus? Several writers, who have pleased themselves with describing what they call a regular gradation or chain of beings, represent man only as a superior kind of monkey; and place the unfortunate African as the connecting link between the superior races of mankind and the orang-outang; they deny, in short, that he is generically distinguished from monkeys. Such an opinion might reasonably be expected from the slave-merchant who traffics in human blood, and from a West Indian Negro driver, who uses his fellow-creatures worse than brutes; but we should not think of finding it defended by the natural historian; and we shall not hesitate to assert, that it is as false philosophically, as the moral and political consequences, to which it would lead, are shocking and detestable. We set out with this position; that man has numerous distinctive marks, by which, under every circumstance of roughness and uncivilization, and every variety of country and race, he is separated, at a broad and most clearly defined interval, from every other animal, even of those classes which, from their general resemblance to the human subject, have been called anthropo-morphous. We cannot, indeed, by any means coincide with those moderns, who have indulged their imagination in painting a certain continuity or gradation of created beings; and who fancy they have discovered great wisdom of the Creator, and great perfection of the creation, in this respect; that nature makes no leaps, but has connected the various objects of the three kingdoms with each other, like the steps of a staircase, or the links of a chain. The candid and unprejudiced observer must allow, that in the animal kingdom there are whole classes, as birds, and particular genera, as the cuttle-fish, which cannot find a place in such a scheme of arrangement, without a very forced and unnatural introduction: and, again, that there are certain genera, as the coccus, where the two sexes are so different from each other, that the male and female must be separated, and occupy different parts of the scale, in this artificial plan of gradation.

It is frequently easier to perceive, as it were intuitively, the distinctive characters of two neighbouring species of animals, than to express them by words. Hence Linnæus, whose sagacity in perceiving the characteristic marks of the various objects of natural history, and in expressing them in appropriate language, has never been exceeded, declares, in his "Systema Naturæ," that the distinctions between man and the monkey still remain to be discovered: "Mirum, adeo parum differre stuttissimam simiam a sapientissimo homine, ut iste geodætes naturæ etiamnum quærendus, qui hos limitet." Accordingly, he gives neither the generic nor specific character of man in that work.

The cirumstances which distinguish man from other animals may be considered under three divisions: 1. Differences in the structure of the body; 2. in the animal economy; 3. in the faculties of the mind.

Under the first head we remark, as the most distinguishing peculiarity of man, his erect stature: that majestic attitude, which announces his superiority over all the other inhabitants of the globe. He is the only being adapted by his natural formation to the upright position. Enslaved to their senses, and partaking merely of physical enjoyments, other animals have the head directed towards the earth: "quæ natura prona atque ventri obedientia finxit." Man, whose more elevated nature is connected to surrounding objects by moral relations, who can embrace in his mind the system of the universe, and follow the

connections of effects and causes, boldly regards the heavens, and can direct his sight even into the starry regions. The physical cause of this noble prerogative will be found in the length and breadth of the feet; in the length and strength of the lower extremities; and in the number and size of the muscles, which extend the trunk upon the lower limbs. (For a more detailed account of this part of the subject, see COMPARATIVE ANATOMY, *muscles.*)

The situation of the great occipital foramen is another circumstance depending on the erect stature of man: and for an account of this subject, we refer to the same part of the article on comparative anatomy, and also to that portion of it which treats of comparative osteology.

The structure of the thorax shews, that man was not designed to go on all-fours. Quadrupeds, if they have long legs, have the chest flattened at the sides, and keel-shaped in front; and they have no clavicles, so that the front legs converge, and fall under the chest, to support the front of the body. Quadrupeds have also a longer sternum, or a greater number of ribs continued towards the crista ilia, and serving the purpose of supporting the abdominal viscera in the horizontal position of the trunk. These things are all differently arranged in the biped man. His thorax is flattened before and behind; his shoulders widely separated from each other by the clavicles; his sternum short, and his abdomen unfurnished with bony parietes in a very large extent. These circumstances, with many others, which could not fail to strike any body who attentively compared the human skeleton with that of the long-legged quadrupeds, shew how ill the human structure is adapted to progression on four feet, which could not be otherwise than unsteady, troublesome, and fatiguing, in the highest degree.

The manner in which the human pelvis differs from that of all other animals, is a further proof of what has been already stated. The broad expansion of the upper part of the ilia forms a firm basis for the trunk; the curvature of the sacrum, and the inclination of the os coccygis forwards, which is a circumstance altogether peculiar to the human pelvis, give to it a capacity exceeding that of any other animal. In the orang-outang the upper part of the ilium is narrow and elongated, stretching upwards in the direction of the spine; the sacrum, flat and contracted, continues in a straight line with the vertebral column.

The relation of the neighbouring soft parts to the pelvis, deserves also to be considered. The posterior surface of the pelvis gives origin to the glutæi muscles, the external of which, exceeding in size all others in the body, and covered by a large proportion of fat, form the buttocks. These fleshy and rounded prominences, between which the anus is deeply hidden, have always been considered, both by the natural historian and the physiologist, as a peculiar characteristic of man, particularly distinguishing him from the simiæ, which have no buttocks at all.

The curvature of the sacrum and os coccygis gives rise to the particular direction of the organs of generation, and especially of the vagina; that canal, which, in the other female mammalia, nearly follows the axis of the pelvis, being placed almost at right angles to that axis in the woman; and hence the process of parturition becomes more difficult. In consequence of this direction of the vagina, the human female is not like that of brutes, retromingent: and the same circumstance will determine a point that has been often agitated, concerning the most natural position for the act of copulation: "quibus ipsa modis tractetur blanda voluptas." For although there are many ways in which this rite may be performed, the relation of the penis to the vagina points out the ordinary method as the most natural.

From the erect stature of man arises another very distinguishing prerogative; the most unconstrained use of his very perfect hands. So greatly does the conformation of these parts excel that of other animals, that Anaxagoras was hence induced to make an observation, which Helvetius has again brought forwards in our times, "that man is the wisest of animals, because he possesses hands." This indeed is too much; yet Aristotle is well justified in observing, that man alone possesses hands really deserving that name. The chief and most distinguishing part of the hand, *viz.* the thumb, is short, slender, and weak, even in the most anthropo-morphous simiæ; so that no other hand but that of the human subject deserves the name given to it by the Stagyrite, of the organ of all organs. (See the remarks on this subject in the article COMPARATIVE ANATOMY.)

The monkeys, apes, and other anthropomorphous animals, can, in fact, be called

neither bipeds nor quadrupeds; but they are quadrumanous, or four-handed. Their posterior limbs are furnished with a thumb, instead of a great toe; which latter part belongs only to man, and arises from the manner in which his body is supported in the erect position. Hence the dispute concerning the mode of progression of the orang-outang and other simiæ; *viz.* whether they go on all fours, or are supported by the posterior limbs only, will be easily settled. Neither of these representations is correct. Since the hands of these animals are not formed for walking, but for seizing and holding objects, it is clear that nature has designed them to live chiefly in trees. They climb these, and seek their food in them; and one pair of hands is employed in fixing and supporting the body, while the other gathers their food, or serves for other offices. Hence some, who have less perfect hands, are furnished with a prehensile tail, by which they can be more securely supported in trees.

It is hardly necessary to add, that when we see monkeys walking erect, it is to be ascribed to instruction and discipline. The delineations of the orang-outang, taken accurately from the life, shew how inconvenient and unnatural the erect posture is to these animals: they are drawn with the front hands leaning on a stick, while the posterior ones are gathered up in the appearance of a fist. No instance has ever been produced of a monkey, nor of any other animal, except man, which could preserve his body in a state of equilibrium, when standing on one foot only. All these considerations render it very clear, that the erect stature not only arises out of the structure and conformation of the human body, but also that it is peculiar to man: and that the differences in the form and arrangement of parts, derived from this source only, are abundantly sufficient to distinguish man by a wide interval from other animals.

The hymen, a part for which no rational use has been hitherto assigned, is peculiar to man; but the nymphæ and clitoris, of which the same assertion has been made, are found also in other animals.

The want of the os intermaxillare has generally been considered as characteristic of the human species. (See COMPARATIVE ANATOMY; *osteology.*)

The teeth of man are distinguished by the circumstance of their being arranged in an uniform, unbroken series. The lower incisors are placed perpendicularly; and the cuspidati neither project beyond the others, nor are separated from them by any interval. The molares are clearly distinguished by their obtuse prominence from those of all the simiæ. The lower jaw is remarkable for three reasons; its shortness, the projection of the chin, and the form and direction of the condyles, as well as the mode of their articulation with the basis cranii; which manifestly point out man as formed by nature to be an omnivorous animal.

In the brain we meet with a very striking difference between man and other animals. The human subject has the largest brain, not in proportion to the rest of the body, but to the size of the nerves, which proceed from it. Hence, if we divide the nervous system into two parts, one consisting of the nerves, and that part of the brain from which they arise, which is to be considered as appropriated to the functions of a mere animal life; the other, comprehending the remainder of the brain, and connecting the functions of the nerves with the faculties of the mind, man will possess the greatest proportion of the latter more important part. (See COMPARATIVE ANATOMY.)

Soemmerring has also shewn, that the calcareous matter of the pineal gland does not exist in any animal but man.

The smoothness of the human integuments, and the want of the hairy covering which other mammalia possess, must be considered as a peculiarity of man. The unanimous reports of all travellers prove beyond a doubt that every species of simia is hairy, and vastly more so than any man: although we read of instances of particularly hairy people, as in some of the South Sea islands; but the descriptions hitherto given are not completely satisfactory. While man is remarkable on the whole for the smoothness of his skin, some parts of his body are even more hairy than those of brutes; as the pubes and axilla.

The orang-outang, which resembles man more than any other simia, has a rib more on each side than the human subject; its sacrum consists of three pieces of bone, instead of five; and it has a peculiar membranous pouch, connected with the larynx.

Under the head of the animal economy, we may observe, as characteristic of man, the long period of infancy, and consequently late arrival at the age of puberty; the menstrual discharge in the female;

and the celebration of the rites of Venus at all times of the year. No other of the class mammalia has the cranium consolidated, nor the teeth appearing at so late an age; none is so late in gaining the power of supporting the body on its limbs, in acquiring the full growth; nor in arriving at the exercise of the sexual functions. To none is there allotted such a length of life, compared with the bulk of the body; and this extension of existence, at its latter part, must be regarded as an ample compensation for the greater length of infancy. But it is in the mind, that nobler part of man, that we find him most remarkably differing from the brute creation. And here all philosophers refer, with one accord, to the enjoyment of reason, as the chief and most important prerogative of the human subject. If we enquire, however, more particularly into the meaning of this word, we shall be surprized to find what various senses different individuals affix to the same expression. According to some, reason is a peculiar faculty of the mind, belonging exclusively to man: others consider it as a more enlarged and exquisite developement of a power, which exists in a less degree in other animals. Some describe it as the combination of all the higher faculties of the mind; while others assert, that it is only a peculiar direction of the powers of the human mind, &c.

The subject may perhaps be more shortly and safely dispatched by considering it *a posteriori;* and placing the prerogative of man in the circumstance of his having brought all other animals under subjection to himself. That he has effected this is obvious; and it is equally clear, that his dominion has not been acquired by superior bodily strength: it can therefore only be referred to the powers of his mind; and to these, whatever be their nature, we give the name of reason. Man is designed to use all kinds of food; and to inhabit every climate of the globe. The unlimited power which he possesses in these respects, gives rise to various wants, from the infinite variety of climate, soil, and other circumstances. Man receives therefore from his Creator the power of invention and reason, which supply his wants. Hence, in the most ancient times, and by the wisest nations, the genius of invention has been honoured with divine worship: it forms the Thoth of the Egyptians, the Hermes of the Greeks. Thus, to give a few instances: man has made tools for assisting his labour; and hence Franklin sagaciously defined man as a "tool-making animal:" he has formed arms and weapons; he has devised various means of procuring fire; and, lastly, for the purpose of communicating with his fellows, he has invented speech. This is to be accounted a most important characteristic of man; since it is not born with him, like the voices of animals, but has been framed and brought into use by himself, as the arbitrary variety of different languages incontestibly proves.

There is some doubt with respect to laughing and weeping; which belong rather to the passions than to reason. It is well known, that many animals besides man secrete tears. But the question is, do they weep from grief? The fact has been asserted by some great men; as by Steller, of the seal; and Pallas, of the camel. But it is very doubtful, whether they ever manifest cheerfulness by laughing.

There are numerous diseases peculiar to the human subject, which it might be considered wrong to speak of in remarks on the natural history of man; yet these unnatural phenomena undoubtedly deserve a place in the discussion, since they arise out of the natural habits of the body. The subject is obscure; since the nosology of brutes is exposed, by its very nature, to the most serious and almost insuperable difficulties. The following may however be considered, with all probability, as diseases peculiar to man: small-pox, measles, scarlatina, petechiæ, plague, hemorrhoids, menorrhagia, hypochondriasis, hysteria, the various affections of the mind, scrofula? lues venerea, pellagra, lepra, amenorrhæa, cancer? hernia congenita? tinea capitis. These, though by no means all, are the chief points of difference between man and other animals: they have been enumerated, we can hardly say considered, in a very cursory manner; otherwise they would have afforded matter for a lengthened disquisition. The peculiarities appear abundantly sufficient to characterise man as a distinct genus; and consequently to overturn the wild chimeras of those visionary speculators, who regard him, in some of his races and modifications, only as an improved orang-outang.

Our next point is the consideration of the varieties of the human species and their causes. This disquisition will perhaps appear superfluous to the devout believer, whose philosophy on this point

will be derived from the writings composed with the assistance of divine inspiration, and therefore commanding our implicit assent. The account of the creation of the human race, and of its dispersion over the face of the globe, contained in the book of Genesis, will supersede in his mind the necessity of having recourse to any argument on the subject. We shall venture to submit, that the Mosaic account does not make it quite clear that the inhabitants of all the world descended from Adam and Eve: we are told, indeed, that "Adam called his wife's name Eve, because she was the mother of all living." But in the first chapter of Genesis we learn, that God created man, male and female; and this seems to have been previously to the formation of Eve, which did not take place until after the garden of Eden had been made. Again, we are informed in the fifth chapter of Genesis, that "in the day that God created man, in the likeness of God made he him; male and female created he them; and blessed them, and called their name Adam, in the day when they were created." We find also that Cain, after slaying his brother, was married, although it does not appear that Eve had produced any daughters before this time. It appears, therefore, that the field is open for discussion on this subject; and at all events, if the descent of mankind from one stock can be proved independently of the holy writings, the conclusion will establish the authority of these inspired annals.

If we fail in tracing the succession of the human race from above downwards, much less are we able to trace back any particular tribe to their first origin from the present stock. To use the words of an elegant modern historian; "neither the annals nor traditions of nations reach back to those remote ages, in which the different descendants of the first pair took possession of the different countries where they are now settled. We cannot trace the branches of this first family, nor point out with certainty the time and manner in which they divided and spread over the face of the globe. Even among the most enlightened people the period of authentic history is extremely short, and every thing prior to that is fabulous and obscure." We must, therefore, in tracing the variations from the original stock, assign those causes, which are well known to have great influence on mankind, as climate, manner of life, state of society, &c.; occasionally deriving assistance from the analogies which are to be met with in the natural history of other animals.

Before we proceed to describe the varieties of the human race, it is necessary to consider, what constitutes a species in zoology; and how varieties arise out of species.

We should answer, in the abstract, to the first question; that all animals belong to the same species, which differ in such points only, as might arise in the natural course of degeneration, while those differences, which could not be explained on this supposition, would lead us to class the animals which exhibit them in different species. But the great difficulty arises, in distinguishing in actual practice mere varieties from specific differences.

Ray, and after him Buffon, referred those animals to the same species which copulate together, and produce a fertile offspring. But this criterion has produced very little benefit; and we probably must be contented to derive our notions of species in zoology from analogy and probability. The molar teeth of the Asiatic and African elephants differ very widely in their conformation; and, as we know no instance of such a difference produced by mere degeneration, we ascribe those animals to species originally different. The white ferret on the contrary we regard as a variety, because we know that the colour of the hair and pupil experiences a similar variation in other instances where it is a mere variety.

In considering the causes by the operation of which species degenerate into varieties, we shall be contented with stating the facts which prove the influence of such causes; without attempting to explain how they produce their effects. As there is very little of a satisfactory nature ascertained respecting this matter, we should be afraid of disgusting the sensible reader by substituting speculation in the place of more solid information.

A very slight consideration will shew that there is no point of difference between the several races of mankind, which has not been found to arise, in at least an equal degree, among other animals, as a mere variety, from the usual causes of degeneration. The instances of this kind are derived chiefly from domesticated animals, as they are exposed

to all those causes which can produce such effects; by living with man they lead an artificial and unnatural kind of life, and are taken with him into climates and situations, and exposed to various other circumstances altogether different from their original destination; hence they run into numerous varieties of colour, form, size, &c. which, when they are established as permanent breeds, would be considered by a person uninformed on these subjects, to be originally different species. Wild animals on the contrary remaining constantly in the state for which they were originally framed, retain permanently their first character. Man, the inhabitant of every climate and soil, partaking of every kind of food, and of every variety in mode of life, must be exposed still more than any animal to the causes of degeneration.

Climate is one of the causes which seems to exercise a powerful influence on the animal economy, and the formation of the body. To this we must ascribe the white colour of several animals in the northern regions, which possess other colours in more temperate countries, *viz.* the fox, hare, falcon, crow, blackbird, &c. That this whiteness must be ascribed to the cold of the climate is rendered probable by the analogy of those animals which change their colour in the same country at the winter season to white or grey: as the ermine and weasel, hare, squirrel, reindeer, &c. &c. The common bear is very differently coloured in different countries. The remarkable silky and white covering of various animals in that district of Asia Minor called Angora must be explained in the same way, rather than from any difference of food; because it occurs in instances where very different kinds of food are used, as in the cat and goat. Hence also we account for the peculiar blackness of the fowls and dogs on the coast of Guinea, and for the change of the woolly covering of the sheep into hair in the same situation.

The effect of climate on the stature of the body is shewn by the smallness of the horses in Scotland and North Wales; and by the remarkable differences in this respect in the different provinces of Sweden. Must we not also explain on the same principle the constant and remarkable degeneracy of the horse in France? According to Buffon, the Spanish or Barbary horses, where the breed is not crossed, degenerate into French horses in the second, or at latest in the third generation.

The effect of *food* on the body is very obvious in the well known fact of several singing birds, chiefly of the lark and finch kinds, becoming gradually black, if they are fed on hemp-seed only. The texture of the hair has been changed, in an African sheep brought into England, from the coarse nature of that of the camel, to considerable softness and fineness, by one year's feeding in the pastures of this country. The influence of the same cause on the stature and proportions of the body is shewn in the horse, which grows to a large size in the marshy grounds of Friesland, while on stony soils or dry heaths they remain dwarfish. Oxen become very large and fat in rich soils, but are distinguished by shortness of the leg; while in drier situations their whole bulk is much less, and the limbs are stronger and more fleshy. I do not advert to the well-known differences of flavour and weight produced by different food.

Manner of life. Under this head we include all those causes which can act on the animal economy besides climate and food; and which, by their long-continued influence on the body, effect considerable changes in it. Culture and the power of habit are the most efficacious of these, and exert a very powerful and indisputable action on our domestic animals. Observe the striking difference of form and proportion between the horse trained in the manege, and the wild, untaught, and unbroken animal. The latter bites rather than kicks; while the former, reined, and armed with iron shoes, uses these as his means of offence. The ass in its wild state is remarkably swift and lively, and still remains so in his native countries in the east. The argali, or wild original of the sheep, is covered with hair instead of wool; and the bison, or wild ox, has a long flowing mane, hanging almost to the ground. Most of the mammalia, which have been tamed by man, betray their subjugated state, by having the ears and tail pendulous. In many, the very functions of the body, as the secretions, generation, &c. are greatly changed. The domestic sow produces young twice a year, and the wild animal only once.

The domestic pig acquires a vast accumulation of fat under the skin, which is never seen in the wild animal, which on the contrary possesses a soft downy hair among its bristles, speedily lost in the

tamed individuals. The domesticated animals become liable to produce monstrous fetuses, and are exposed to new and numerous diseases: their bodies are even invaded by new kinds of worms, of which the hydatids in swine, forming what is commonly called the measles, are an indubitable instance.

The three causes now mentioned produce their effect in changing the original character of the animal, and giving origin to a variety, only after a great length of time, and a continued action through several generations. But these changes are communicated much more quickly by the process of generation. When two varieties copulate together, the offspring resembles neither parent wholly, but partakes of the form and other peculiarities of both. This cannot with propriety be termed hybrid generation; as authors apply that expression to the produce of the copulation of different species, as of the horse and ass, &c. In this sense hybrids are never produced in the human species: for although we read various instances of men and women having commerce with animals, there is not a shadow of reason for supposing that such copulations ever produced an offspring. Breeding from different varieties has a great effect in changing the colour and form of the animal produced; and hence this method of improving and ennobling the race is practised with great effect in the domestic animals, particularly the horse and sheep.

It seems even possible that a disposition originally morbid may be transmitted by generation, and acquire a permanent character. The peculiar whiteness of the skin, with red colour of the eye, occurring in the rabbit and ferret, and various other animals, as well as in the Albino of the human race, appears in the first instance to be a morbid affection of the body; and when it occurs in one or two instances only, in the human subject, has the appearance of a leprous cachexy. But, in the animals just mentioned, all the unnatural characters have been lost, and it is established as a permanent variety. We have, moreover, many facts, shewing that, in some cases, casual mutilations are transmitted to the offspring: as want of tail in a cat or dog. (Philosophical Magazine, vol. iv. p. 2. Anderson's Recreations, vol. i. p. 69.) The Jews are frequently born with so little foreskin, that it is hardly possible to circumcise them: this they call being born circumcised. (Philosophical Magazine, vol. iv. p. 5.)

In applying the reasonings derived from the causes just mentioned, it may not be amiss to advert to the following rules:—1. The greater the number of causes of degeneration, and the longer they continue to act on the same species, the more obviously will that species deviate from its original formation. Man, therefore, must be expected to vary more than any animal, since he has been subjected from his very origin to the united agencies of climate, food, and way of life. 2. A cause, possessing in itself sufficient efficacy, may be weakened by the concurrence of other conditions, tending to diminish its operations. Thus, countries placed under the same parallel of latitude have very different temperatures; and the effects of situation on the human subject are varied, according as it is more or less elevated, or as it may be influenced by the neighbourhood of the sea, marshes, mountains, or woods, &c. 3. The source of degeneration is often to be sought for, not in any immediate cause, but in the mediate influence of some more latent agency. Thus, the dark colour of the skin may not arise from the direct action of the sun, but from its more remote, but very signal, influence on the hepatic system. 4. These indirect and mediate causes may be so very obscure, that we cannot form even any probable conjecture as to their nature; yet we seem to be warranted in referring those phenomena of degeneration, which hitherto appear enigmatical, to the operation of such unknown powers. Thus we must explain the constant national forms of crania, colours of the eye, &c.

VARIETIES OF THE HUMAN RACE.

The *colour of the skin* forms a very constant hereditary character, most clearly influenced by that of both parents in the hybrid offspring of different varieties, having a close and nearly uniform relation to that of the hair and iris, and indeed to the whole temperament of the individual; and for all these reasons attracting most immediately the attention of the cursory observer.

The seat of this colour is in a thin mucous stratum, interposed between the cuticle, or dead surface of the body, and the true skin, and called rete mucosum, or rete Malpighii. The native reddish white of the real skin appears through this, which is very thin and almost colourless, in the white races of mankind. But in the darker varieties the rete mucosum is much thicker, and contains throughout

its substance a black pigment; while the cuticle and cutis deviate but little from the colour which they have in fair persons.

The different varieties of mankind exhibit every possible shade, between the snowy whiteness of the European female and the jet black of the Negro. Although none of these gradations obtain so universally, as to be found in all the individuals of any particular nation, nor are so peculiar to one race, as not to occur occasionally in other widely different ones, the national varieties of colour may be referred on the whole, with sufficient accuracy, to the five following principal classes.

1. White, to which redness of the cheeks is almost wholly confined, being observed at least very rarely, if at all, in the other varieties. This obtains in most of the European nations, in the western Asiatics, as the Turks, Georgians, Circassians, Mingrelians, Armenians, Persians, &c. and in the inhabitants of the northern parts of Africa.

3. Yellow, or olive (a middle tint between that of wheat and boiled quince, or dried lemon peel), which characterises the Mongolian tribes, usually called, together with the inhabitants of great part of Asia, Tartars.

3. Red, or copper colour (*bronzé*, Fr. an obscure orange, or rusty iron colour, not unlike the bark of the cinnamon tree) almost confined to the Americans.

4. Tawny, or brown (*basané*, Fr. a middle tint between that of fresh mahogany and cloves or chesnuts) which belongs to the Malays, and the inhabitants of the South Sea islands.

5. Black, in various shades from the sooty colour, or tawny-black, to that of pitch, or jet-black. This is well known to prevail very extensively on the continent of Africa: it is found also in other very different and distant varieties of the human race, mingled with the national colour, as in the natives of Brazil, California, India, and some South Sea islands, as New Holland and New Guinea. In describing these five varieties, we fix on the most strongly marked tints, between which there is every conceivable intermediate shade of colour. The opposite extremes run into each other by the nicest and most delicate gradations, in every other particular in which the human species differs. This forms no slight objection to the hypothesis of different species. For, on that supposition, we cannot define the number of species, nor can we point out the boundaries which divide them; whereas in animals, which most resemble each other, the different species are preserved pure and unmixed. Neither does the colour, which we describe in general terms as belonging to any particular race, prevail so universally in all the individuals of that race as to constitute an invariable character, as we should expect, if it arose from such an uniform cause as an original specific difference: its varieties, on the contrary, point out the action of accidental circumstances. Thus, although the red colour is very general on the American continent, travellers have observed fair tribes in several parts; as Bouguer in Peru, Cook at Nootka Sound, and Weld near the United States. The natives of New Zealand vary from a deepish black to an olive, or yellowish tinge; in the Friendly Islands they are of a complexion deeper than the copper brown; but several of both sexes are of the olive colour, and some of the women are much fairer.

Climate has generally been regarded as the cause of national colour, and much has been ascribed to the light and heat of the sun. According to the supporters of this opinion, every parallel of latitude is marked with a characteristic complexion. Under the equator we observe the black colour; under the tropics, the dark brown and copper colours; and, from the tropic of Cancer northwards, we discern the olive changing through every intermediate shade to the fair and sanguine complexion. It is further observed, that an European, exposed to the sun and air, will become brown in summer, and lose this colour again during the winter's cold; that the Asiatic and African women, confined to the walls of their seraglios, are as white as Europeans, while the colour of those exposed to the rays of the sun is dark, like that of the men; that the skin of the Moorish children, which is originally fair and delicate, changes in the boys, who are exposed to the sun, to a swarthy colour, while its fairness is preserved in girls, who keep more within doors: that the South of Spain is distinguished by complexion from the north; and that the inhabitants of the extensive empire of China exhibit every variety of complexion from the fair to the black, according to the latitude of the country which they inhabit. It appears also, that although fair persons have their colour considerably deepened by changing into a hotter climate, yet that the black races are very little affected by coming into cold countries. We must remember too, if Europeans seem to be less affected than

we should have supposed by changing to a hot climate, that by avoiding the heat of the sun, by different clothing, diet, &c. they may avoid many of the causes which act with full energy on the natives of such climates. The proximate cause of the dark colour of the skin consists, according to Blumenbach, (de Gen. Human. Var. Nat.) in the secretion of a greater quantity of carbon, and its fixation, by an union with oxygen, in the rete mucosum. He states, that Negroes are not born black, but acquire that colour by the access of the atmosphere. He also insists much on the influence which heat exerts on the hepatic functions; and the sympathy existing between the liver and skin, manifested by the dark tinge of the latter in persons of an atrabilarious temperament. There is no climate so favourable for the operation of these causes as that of Africa, which surpasses all others in the continued intensity of its heat, in peculiar properties of the atmosphere, arising from very singular winds, &c. Accordingly, its inhabitants having, by exposure to these agencies for a long series of ages, acquired a strongly-marked and deeply-rooted character, transmit it unimpaired, even in foreign climates, to their descendants.

There are varieties of colour in animals, which, whether they owe their origin to climate or other causes, are as remarkable as those of the different races of mankind, although they occur in the same species. The swine are all white in the northern provinces of France; in Dauphiny, and some other parts, they are black, as also in Spain, Italy, India, China, and America; and in Bavaria, reddish brown. The breeds of cattle manifest similar variations. We have already noticed the changes of colour in animals in cold climates, in speaking of the influence of climate.

Some objections have been made to the explanation of colour derived from climate, which seem to admit of solution. The temperature of any country cannot be determined by considering merely its geographical climate, or its distance from the equator: we must advert at the same time to the physical climate, or that which is produced in any given latitude by such adventitious circumstances as low or elevated position, neighbourhood of water, &c. &c. The Abyssinians, although nearly under the equator, by no means approach in colour to Negroes; for their country is very elevated, the barometer standing, according to Bruce, at twenty-two inches. The inhabitants of the South Sea islands under the line, and indeed of the South Sea islands in general, are much lighter coloured than we should have expected; and this arises from the coolness natural to insular situations. We find no Negroes under the line in America, as in Africa; a circumstance which admits of an easy solution. On the western side of America there is one of the most elevated regions of the globe. The plain of Quito, which is the base of the Andes, is higher than the top of the Pyrenees, and the summits of these mountains, although in the centre of the torrid zone, are covered with everlasting snow. The country abounds with large rivers, traversing it from west to east. It is covered by a vast quantity of stagnant water, and the largest forests in the globe; it contains no sandy wastes, like those of Africa. Hence the temperature of any place in America is very different from that of corresponding parts of the old continent. At Quito, which is nearly under the line, Reaumur's thermometer never ascends beyond 28°; while at Senegal, in 16° of north latitude, it mounts to 38°. The latitude of Paris corresponds to that of Quebec, and that of London to the almost uninhabitable regions of Labrador.

The brown and tawny colours are not wholly confined to warm climates; they are found in the northern regions of Europe and Asia, countries which, from their excessive cold, and consequent sterility, are scarcely habitable. The inhabitants of these regions live on the flesh of the rein-deer and dried fish; their bread is made of pounded fish-bones with the bark of the pine or birch-tree. They drink much whale oil. They live under ground, or in huts sunk below the surface of the earth; and during their long nights keep up lamplight, and are enveloped in smoke. At other times they are exposed to the action of a most inhospitable climate, in following their occupations of hunting and fishing. This mode of life will naturally render the skin coarse and dark; and the discoloration thus produced is increased in many instances by the habit of painting the body, and smearing it with grease and other substances, which very commonly prevails among savage nations. Such an effect is produced sometimes by these practices, that the colour of the skin cannot be ascertained. (Hawkesworth's Collection of Voyages, &c. vol. iv. p. 24, 120, 138.)

We have to observe further, that the effect of climate is much modified by

clothing, by the state of society, and the manner of life in general. Dr. Smith (Essay on Complexion and Figure,) informs us, that in America, the field slaves, who are badly fed, clothed, and lodged, are remote from the society and example of their superiors, and retain many of the customs and manners of their African ancestors, are slow in changing the aspect and figure of Africa; while the domestic servants, who are employed in the families of their masters, see their manners, and adopt their habits, have advanced far before them in acquiring the agreeable and regular features, and the expressive countenance, of civilized society. He also mentions, that persons who have been captured from the States, and have grown up in the habits of savage life, contract such a strong resemblance of the natives in their countenance, and even their complexion, as to afford a striking proof, that the differences which exist in the same latitude, between the Anglo-American and the Indian, depend principally on the state of society.

Perhaps the strongest circumstance, in illustration of the effect of climate on the human complexion, may be derived from the Creoles, which word, sometimes strangely confounded with that of Mulatto, is applied properly to the offspring of European parents born in the East or West Indies. These have such a peculiar character of complexion and countenance, ("austrum quasi spirans vultus et color, maxime quoque comæ et ardentium quasi oculorum,") that they are easily distinguished by those points alone, from their relations born in Europe. (Hawkesworth's Collection, vol. iii. p. 374.) The same observation holds good also of the offspring of Persian or Mongolian parents born in the East Indies. (Hodge's Travels in India, p. 3.)

COLOUR AND DENOMINATIONS OF THE MIXED BREEDS.

We have already noticed how constantly the children, produced from the copulation of individuals of different races, exhibit what we may call the middle tinge, formed as it were by the mixture of those of the two parents.

In the first generation, the offspring of Europeans and Negroes are called Mulattoes; of Europeans and Indians, Mestizes; of Europeans and Americans, Mestizes, also Mestindi, Metifi, and Mamelucks; of Negroes and Americans, Zambi, or Mulattoes, or Lobos, Curibocas, and Kabuglos. All these have the middle countenance and colour, formed by the union of those of both parents; the latter is more or less brown or tawny, with hardly any visible redness of the cheek. The hair of the Mulatto is curled, in the other instances straight, and almost invariably black; the iris is brown.

In the second generation, two Mulattoes produce Casquos; an European and Mulatto, a Terceron, who is called by some a Morisco, or Mestize. The hair and countenance of these resemble those of the European; the skin has a slight brown tint, and the cheeks a degree of redness; the scrotum is blackish in the male, and the labia pudendi rather purple in the female. A Negro and Mulatto produce Griffos, Zambos de Mulata, or Cabros; an European and Indian Mestize, Castissos; an European and American Mestize, Quarterons; an American and a Mestize, Tresalvos; an American and Mulatto, Mestizes; an European and Zambo, Mulattoes; two Zambos, Cholos.

In the third generation, Europeans and Tercerons produce Quarterons, Ochavons, Octavons, or Alvinos; which, according to the most acute observers, retain no traces of their African original. A Mulatto and Terceron produce a Saltatra; an European and Castisso, a Postisso; an European and American Quarteron, an Octavon. Some carry the genealogy of these hybrid races into the fourth generation, calling the children of Europeans and Quarterons, Quinterons; but it is not credible that any trace of mixed origin can remain in this case, according to the observation of the most respectable eye-witnesses concerning the third generation. Besides the varieties of colour already noticed, there is a deviation sometimes occurring in the Negro, consisting of white portions of skin of various sizes and numbers, scattered over the body; these are called piebald Negroes, and are produced from two black parents. The appearance is probably owing to some altered action of the skin, and seems analogous to the blackening of portions of the surface, which has been observed in Europeans, particularly in pregnant females.

The skin differs also in some other properties besides its colour. Travellers have described it as remarkably soft and smooth, and as it were silky, in the Carib, Negro, Otaheitean, and Turk. It secretes a matter of peculiar odour in some races, as the Carib, Negro, &c.

The *hair*, as it grows and is nourished from the common integuments, is con-

nected with them in many points by a close kind of sympathy. Hence, the spotted Africans have different coloured hairs. Every gradation of colour, from the fair to the black, is accompanied by its correspondent alterations in the hair. This is true, not only of nations, but also of individuals. A light complexion is accompanied with red or fair hair, a dark one with black hair, almost invariably, even in individuals of the same family; a difference, which, according to the philosophy of some writers, would be a sufficient ground for classing them in different species. The other properties of the hair vary, as well as its colour; and these changes may be brought under the four following varieties:

1. Brownish, or red, deviating into yellow and black; this is copious, soft, and long, and slightly undulated: it obtains in most of the temperate climates of Europe; and was formerly particularly noticed in the Germans.

2. Black, strong, straight, and thin; occurring in the Mongolian and American races.

3. Black, softer, dense, and copious, and curled; observable in most of the South Sea islanders.

4. Black and crisp, so as generally to be called woolly; common to all the Ethiopians.

The above division, although sufficient for general purposes, is not uniformly true. For the woolly hair is not confined entirely to the Ethiopian, nor is a black colour invariably found in all the three last varieties. Some tribes of Africans have long hair, and other red coloured people, as those of the Duke of York's Island, have it woolly. The New Hollanders form so complete a medium between the woolly haired African, and the copious curling hair of the other South Sea islanders, that we are completely puzzled how to class them.

Many instances are recorded of red hair in individuals, of such varieties as commonly have it black, as in some South Sea islands.

Some facts seem to indicate, that climate and mode of life have considerable influence on the hair. Dr. Smith observes, that the hair of Europeans, settled in America, changes visibly towards that of the American Aborigines; so that in the second and third race, straight lank hair is almost universal. In Angora, a small district of Asia Minor, the sheep, goats, cats, and rabbits, have always been celebrated for the uncommon length and fineness of their hair. The common sheep in warm climates is covered with hair, instead of wool. That the mode of life will influence the hair, is very certain; the wild pig has a soft curling hair interposed between its bristles, which in the domesticated animal is entirely lost. The influence of various causes, which may be comprehended under the general term of cultivation, is very striking in the sheep and goat; the great difference in the wool produced from the former, under various circumstances, is well known; and a person, who was acquainted with the covering of the goat in European climates, would hardly believe it possible, that the material from which the precious shawls of Cashmere are manufactured, could be produced from the same animal.

Colour of the iris. It has long been observed that the colour of the eyes depends on that of the skin; and that these organs are blue or light in fair, and dark in black persons. Hence, newly born children, in these climates, have generally bluish eyes and light hair; and the colour of both changes together at a subsequent period, in the individuals who are of a dark complexion. And in the same way, when the hair loses its colour in old age, the pigment of the eye becomes lighter. This connection is still more strongly evinced in spotted animals; and is particularly clear in the rabbit. The native and wild gray kind has a brown iris: the black and white variety has it spotted: and the perfectly white has it red, from the entire absence of colouring matter.

There are three principal varieties of colour in the iris: first, blue; secondly, gray; thirdly, brown, tending to black. These may all occur in different individuals of the same race; and again, they are sometimes confined to the different tribes of the same country, within the boundaries of a few degrees. Thus Linnæus describes, in Sweden, the Gothlander with white hair and grayish blue eyes; the Finlander, with red hair, and brown iris; and the Laplander, with black hair and iris. The ancient Germans were distinguished by their blue eyes, as well as red or rather yellow hair (cærulei oculi, rutilæ comæ, Tacitus). The iris of the Negro is the most intensely black, so that in living individuals it can be distinguished from the pupil only by very close inspection.

The Albino. We shall introduce in this place our observations on that singular variety of the human race; termed the

Albino. We have already stated that the white rabbit and ferret, characterised by the snowy colour of their hair and redness of the eye, seem to have originated from a morbid disposition transmitted by the way of generation, divested in course of time of all character of disease, and established into a permanent variety. The same affection occurs in the human race, but in few and scattered instances, and the persons thus distinguished are named albinos. There are two peculiar circumstances in these individuals. The skin has an unnatural whiteness, often seeming to approach to a slight degree of lepra; and the hair of all parts of the body has the same character. The latter has not the snowy whiteness of old age, nor the elegant light yellow or flaxen appearance of the fair-haired in our climates, but is rather to be compared to the appearance of cream: neither is the colour of the skin like that of the European, but approaching to that of milk, or of a white horse. The eye is deprived of its colouring matter; and hence the iris is of a pale rose colour, and the pupil intensely red, in consequence of the blood contained in the numerous vessels, which almost entirely make up the substance of those parts. Thus there is a general deficiency of colouring matter; as well of that of the skin and hair, as of the eye. These affections of the skin and eye are always concomitant. There is generally also a weakness of the latter organ, in consequence of which a strong light cannot be borne. Hence they are described in Java and the isthmus of Darien as going about chiefly by night, when they see best. This peculiarity always exists from the time of birth; it never changes afterwards, and it is sometimes hereditary.

It was observed first in the African, as the great difference of colour would render the variation more striking; and hence the individuals were termed Leucæthiopes, or White Negroes. From their avoiding the light the Dutch gave them the contemptuous name of Kackerlacken (insects shunning the light): the Spaniards called them Albinos, and the French Blafards. So far, however, is this variety from being peculiar to the Negro, or even to the torrid zone, that there is no race of men, nor any part of the globe, in which it may not occur. Blumenbach has observed sixteen instances in Germany; and refers to various authors who have seen it in most parts of the world. (De Gen. Hum. Variet. sect. 3, §. 78). It happens in many of the class mammalia and birds.

National features. Although it is a common and very just observation, that two individuals are hardly to be met with possessing exactly the same features, yet there is generally a certain cast of countenance common to the particular races of men, and often to the inhabitants of particular countries. The national varieties of countenance may be reduced to the five following:

1. An oval and straight face, with the different parts moderately distinguished from each other; forehead rather flattened; nose narrow, and slightly aquiline; no prominence of the cheek-bones; small mouth, with lips slightly turned out, particularly the lower one; a full and rounded chin. This is the kind of countenance which accords most with our ideas of beauty. It may be considered as a middle, departing into two extremes, exactly opposed to each other; of which one consists in a lateral expansion of the face; and the other in its being extended downwards. Each of these includes two varieties, which are most readily distinguished by a profile view: one, in which the nose and other parts run together, and the other, in which they are more prominent and separate.

2. Broad and flattened face, with little distinction of parts; broad space between the eyes; flat nose; rounded cheeks, projecting externally; narrow and linear aperture of the eye-lids; slight projection of the chin. This is the face of the Mongolian tribes, commonly, but erroneously, called the Tartar face.

3. Broad face and prominent cheek-bones, with the parts projecting more in a profile view; short forehead; the eyes more deeply seated; the nose rather flattened, but prominent. Such is the countenance of most of the Americans.

4. Narrow face, projecting towards its lower part; arched forehead; projecting eyes; a thick nose, confused on either side with the cheeks; the lips, particularly the upper one, very thick; the jaws prominent; and the chin retracted. This is the Negro countenance.

5. The face not so narrow as in the preceding; rather projecting downwards, with the different parts more distinct; the nose rather full and broad, particularly towards its end; the mouth large. This belongs to the Malay race, and particularly to the inhabitants of the South Sea islands.

Here, as on the subject of colour, the different characters run into each other by the most gentle gradations; so that although any two extremes, when contrasted, appear strikingly different, they are connected by numerous intermediate, and very slightly differing shades. And no formation is exhibited so constantly in all the individuals of one race, as not to admit of numerous exceptions. Blumenbach states, that of the numerous African individuals whom he has attentively observed, of the portraits and profiles of others, and of the various Negro crania which have come under his inspection, no two were exactly alike; but several differences appeared, constituting an insensible gradation towards the other varieties, even in their most agreeable modifications. Vaillant says of the Caffre women, that setting aside the prejudice which operates against their colour, many might be accounted handsome even in an European country; Le Maire makes the same observation concerning the Negresses of Senegal and Gambia; and the accurate Adanson confirms it of the Senegambians, which possess, according to him, beautiful eyes, small mouth and lips, and well proportioned features; many, he says, are perfect beauties. The testimony of Mungo Park is to the same effect concerning the Jaloffs, which have not the protuberant lip, nor flat nose, of the African countenance. The features of the Friendly Islanders vary much, according to Cook; he saw many genuine Roman noses, and hundreds of European faces among them.

It is obvious that the causes of national variety in the features must be much the same with those that influence the form of the head, as much must depend on the bones both of the cranium and face. It is difficult, and perhaps impossible, to assign any very satisfactory ones. Climate has been considered a leading circumstance; but we cannot readily understand how that can operate; and some facts militate particularly against its efficacy, as the peculiar characters of the Jew and Gipsy countenance preserved, after such long residence in very different climates from that of their original abode; on the contrary, the common origin of the Laplander and Hungarian, who differ widely in features, seems to countenance the opinion.

Form of the cranium. It is sufficiently obvious that there must be a close connexion between the external parts of the face, or the features, and the bony compages which lies under and supports these; so that we might venture to affirm that a blind man, if he knew the vast difference which exists between the face of a Calmuck and that of a Negro, would be able to distinguish the crania of these two races of mankind by the mere touch. Nor could you persuade any person, however ignorant of the subject, that either of these skulls belonged to a head, similar to those from which the divine examples of ancient Grecian sculpture were copied. Thus much is clear and undeniable, as to the general habit and appearance of the skull. A more careful anatomical investigation of genuine specimens of the crania of different nations, will throw still further light on the subject of the varieties of the human race. Such a comparison will shew us that the form of the cranium differs no less than the colour of the skin, or other characters, in different individuals; and that one kind of structure runs by gentle and almost inobservable gradations into another; yet that there is on the whole an undeniable, nay, a very remarkable constancy of character, in the crania of different nations, contributing very essentially to national peculiarities of form, and corresponding exactly to the features, which characterise such nations. Hence, anatomists have attempted to lay down some scale of dimensions, to which the various forms of the skull might be referred; and by means of which they might be reduced into certain classes. Of these, the facial line of Camper claims the most attention; its application is explained in the article on COMPARATIVE ANATOMY. Considered in a general view, this is objectionable, as it only indicates the differences in the projection of the jaws. Blumenbach states that the most important points, those especially which contribute to the comparison of national characteristics, can be most completely observed by placing the different crania, with the zygomas in the same perpendicular line, on a table in a row, and contemplating them from behind. This method he calls the norma verticalis: and illustrates by means of three heads. The middle of the three, distinguished by the beauty and symmetry of all its parts, is that of a Georgian female; the two outer ones are examples of heads differing from this in the opposite extremes. That which is elongated in front is the head of a Negress, from the coast of Guinea: the other, which is expanded laterally, and

flattened in front, is the cranium of a Tungoose, from the north-east of Asia. The margin of the orbits and the zygoma are elegantly contracted in the Georgian; and the jaws are hidden by the symmetrical expansion of the forehead. In the Ethiopian the maxillary bones, and indeed the whole face, are compressed laterally, and project in front. In the Tungoose, on the contrary, the ossa malæ, ossa nasi, and glabella, are situated on the same horizontal level, and are enormously expanded on either side. (Two plates illustrating the national formations of the skull are given in Rees's New Cyclopedia, in which the subject itself has been considered at greater length, under the article CRANIUM, by Mr. Lawrence).

The national forms of the cranium may be referred to five chief divisions. The first presents a somewhat globular form; with the forehead moderately expanded; the cheek-bones narrow, and not prominent, but descending in a straight line from the external angular process of the os frontis. The alveolar margin of the jaws is rounded; and the front teeth of both jaws are placed perpendicularly. This form is observable in most Europeans. The cranium of the Turk is particularly globular in its form. This shape, which they consider as elegant, and adapted to their turbans, is said, on very good authority, to be produced by artificial pressure after birth.

In the second variety, including the Mongolian tribes, the head is of a square form, and the cheek-bones stand out widely on either side. The glabella, and ossa nasi, which are flat and very small, are placed nearly in the same horizontal line with the ossa malarum. There are scarcely any superciliary ridges; the entrance of the nostrils is narrow; and the malar fossa forms but a slight excavation. The alveolar edge of the jaws is obtusely arched in front; the chin rather prominent.

The third variety contains the Africans. The cranium is narrow, being compressed at the sides, where the temporal fossa is of immense extent. The forehead is narrow, and strongly arched; the cheek-bones project anteriorly; the nostrils are large; the mala fossa considerable and deep; the alveolar edges of both jaws stand very much forwards; they are narrow, elongated, and of an elliptical figure; the front teeth of the upper jaw are oblique in their position; the lower jaw is large and strong; but the chin, instead of projecting as far as the teeth, as it does in the European, recedes considerably, as in the monkey. The substance of the cranium is generally thick, and the skull is consequently heavy. A slight comparison of the Negro with the European skull, will suffice to shew that the cranium is more capacious in the latter than in the former case. The lateral compression of the Ethiopian head, together with its narrow arched forehead, compared to the almost globular European cranium, with its broad expanded frontal portion, sufficiently account for this difference. At the same time, the bones of the face are proportionably larger in the African; the foramina for the transmission of nerves are more ample; and, according to Soemmerring, the nerves arising from the basis of the brain are more considerable. The result of these observations, together with the unequivocal similarity in external form between the African cranium and that of the monkey, leads us inevitably to the inference that the Negro approximates in structure to those animals. The facts which we possess on this subject confirm the conclusion, which would naturally be drawn from these premises, that the mental faculties of the Negro are inferior to those of the white nations. Let it not, however, be conceived that these remarks are intended to degrade the African to a level with brutes, or to justify those who consider him merely as a species of monkey. He is distinguished from all animals by the same grand and constant characters, which belong to every variety of the human race. We merely state the obvious inferences deducible from acknowledged facts; and consider that a difference in mental powers cannot afford any stronger argument in proof of a diversity of species, than the numerous distinctions in bodily structure. Indeed, when we find the different races of mankind characterized by such numerous differences of organization, it would be a matter of surprise, if no diversity could be discovered in their mental endowments. The description which we have given above of the Negro cranium must be understood in a general sense, and not as universally and unexceptionably applicable. Travellers inform us that several Africans differ from the European features and physiognomy only in colour; so that the peculiar formation of the cranium on the faith of which some philosphers would class these people as a distinct species, is by no means a constant character.

The two next varieties are not so strongly characterized as the three

which we have already considered. They form indeed two intermediate gradations, between the European and the Mongolian on one side, and the African on the other.

In the fourth, or American variety, the cheeks are broad, but the malar bones are more rounded and arched than in the Mongolian; and not expanded to such an extent on either side, nor possessing such an angular form. The orbits are generally deep. The form of the forehead and vertex is influenced in many instances by the efforts of art. This is most strikingly evinced in the head of the Carib, in which the upper part is sometimes literally flattened to a level with the eye-brows, in a manner which could not be credited, unless upon the most unexceptionable testimony. It appears, from the relation of travellers, that they employ different methods of accomplishing their object; as by tying a plate of wood on the forehead; or by compressing the head between two plates; or by pressure with the hand. The instruments and bandages, by which the pressure is made, are delineated and described by Dr. Amic, of Guadaloupe, in the xxxixth. vol. of the Journal de Physique.

In the fifth, or Malay variety, the cranium is moderately narrowed at its upper part; the forehead rather expanded; and the upper jaw slightly prominent.

We cannot at present deliver any very satisfactory account of the causes of those differences, which unquestionably prevail in the form of the cranium in the different varieties of the human species; much less are we able to understand the manner in which any assigned cause may be supposed to operate in producing its effect.

It certainly happens in many instances, that the bones of the skull receive a peculiar form from various artificial causes. Not to mention the flattened occiput of the Germans in the time of Vesalius, there can be no doubt that the form of the forehead in the Carib cranium is owing to artificial pressure. A similar rage for improving the shape of the head has been very prevalent on the continent of America. "The Indians," says Adair, "flatten their heads in divers forms; but it is chiefly the crown of the head they depress, in order to beautify themselves, as their wild fancy terms it; for they call us long-heads, by way of contempt." (History of the American Indians, p. 8.) The method by which they accomplish their purpose is thus described by the same author. "They fix the tender infant on a kind of cradle, where his feet are tilted above a foot higher than the horizontal position; his head bends back into a hole made on purpose to receive it, where he bears the chief part of his weight on the crown of the head, upon a small bag of sand, without being in the least able to move himself. By this pressure, and their thus flattening the crown of the head, they consequently make their heads thick, and their faces broad. It is a matter of surprise, that any person should have ventured to call in question the truth of a fact, supported by the concurrent testimony of so many eye-witnesses. Many tribes, both of North and South America, are distinguished by names derived from these very practices. The word *Omaguas*, as applied to a nation of Peru, as well as that of *Cambevas*, in the language of Brazil, signifies flat-head: for these people have the strange custom of pressing the forehead of their newly-born children between two plates in order to make them, as they say, resemble the full moon." (Condamine in the Memoirs de l'Acad. des Sciences, 1745, p. 427.) Hence also the "tetes de boule," and the "tetes plates," of Charlevoix.

We have one remark only to add on this part of the subject; *viz.* that the differences in the form of the cranium are by no means sufficient to authorize us in assigning the different races of mankind in which they occur to species originally different: for they are not more considerable, nor even so remarkable, as some variations which occur in animals confessedly of the same species. Thus the head of the wild boar is widely different from that of the domestic pig. The different breeds of horses and dogs are distinguished by the most striking dissimilarities in the head: in which view the Neapolitan and Hungarian horses may be contrasted. The wild original of the cow possesses large lacrymal fossæ, which are completely lost in the domesticated animal. The very singular form of the head in the Paduan fowl is a more remarkable deviation from the natural structure, than any variation which occurs in the human cranium.

VARIATIONS IN THE FORM AND SIZE OF CERTAIN PARTS OF THE BODY.

The ears are movable, and stand at some distance from the head in many sa-

vages, where they have not been confined by dress.

The lobulus is increased and elongated considerably by artificial means in some of the South Sea islanders, and in other instances.

Many travellers have remarked, that the breasts are long and pendulous in several savage tribes, particularly in Africa and the South Sea islands; but some of the accounts are undoubtedly exaggerated, and the circumstance does not in any case seem common to a whole tribe or nation. The cause seems to consist in long continued suckling, and in the habit of suckling the children at the back of the mother. In some cases artificial means of elongating these parts are employed, from peculiar notions of beauty. A large and swoln state of the breast altogether was observed formerly in the Egyptians; and the Portuguese women of modern days are said to be remarkable in the same way.

Negroes are particularly famous for their organs of generation: and specimens preserved in anatomical cabinets seem to justify their celebrity for the size of these parts; but it is doubtful whether this be a general character. The Hottentot women possess large nymphæ, which cover the opening of the vagina, and have given rise to some absurd reports of travellers.

The legs of the Hindoos are said to be particularly long, and those of the Monguls short: it has also been stated, that the constant practice of riding renders them crooked in the Calmucks. In the Negro they are curved, so as to render the individual knock-kneed; and the calf is remarkably high: they are also distinguished by the broad and flat form of the foot.

Although we cannot assign any satisfactory reasons for all these varieties, there is none which does not exist in a still greater degree in animals of the same species. What differences in the figure and proportion of parts do we observe in the various breed of horses; in the Arabian, the Barb, and the German! How striking the contrast between the long-legged cattle of the Cape, and the short-legged of England! The same differences in the legs are seen in swine. The cows have no horns in some parts of England and Ireland; in Sicily, on the contrary, they are very large. We should also mention here a breed of sheep with an extraordinary number of horns, as three, four, or five, occurring in northern countries, and accounted a mere variety, (*ovis polycerata*); the Cretan breed of the same animal, with long, large, and twisted horns; the Solidungular swine, with undivided hoof, as well as others with three divisions of that part; the five-toed fowl (*Gallus pentadactylus*); the broad-tailed sheep of Tartary, Thibet, &c. in which the tail grows so large, that it is placed on a board, supported by wheels, for the convenience of the animal; and the rumpless fowl of America, and particularly Virginia (*Gallus Ecaudatus*), which has undoubtedly descended from the English breed.

Stature. No part of our subject has been more disgraced by fables and hyperbolical exaggeration, than the present division. Not to mention the pigmies and giants of antiquity; the bones of different large animals, ascribed to human subjects of immoderate stature, even by such men as Buffon, sufficiently prove our assertion. The accuracy of modern investigation has, however, so completely exposed the extravagance of such suppositions, that we are relieved from the necessity of a detailed consideration. All the remains of antiquity, which afford us any inferences on the subject of stature, such as mummies, human bones, and particularly teeth taken from the oldest burial places and urns, armour, &c. concur in proving, that the ancients did not exceed the moderns in this respect. Yet amongst the latter there are obvious national differences. Of European nations some parts of Sweden and Switzerland are distinguished for tallness, as Lapland is in the contrary respect. The Abipons in the new world are of large size, and the Esquimaux small; but neither are very remarkable: and there is no such difference between any two modern nations, but what admits of easy explanation from the common causes of degeneration, and the analogous phenomena furnished by the natural history of other animals.

The Patagonians, or Tehuels, which occupy the south-east part of the extremity of South America, seem to be the tallest of the human race; but their height has been much exaggerated. Pigafetta, who accompanied Magalhaens on his voyage round the world, asserted that they were twice as tall as Europeans, and the accounts of subsequent navigators have been very contradictory. They seem, in truth, to be a tall, though not gigantic race, and to possess a muscular frame. According to Wallis, Bougainville, and Carteret, the ordinary height may be six

feet; and none seem to exceed six feet and seven inches: a stature not so very remarkable, since other native tribes of the same continent have been remarked for their height. As they are a wandering race, we cannot be surprised at finding that Europeans visiting the coast have not always been able to see them. The accounts of travellers prove, that the height of the Patagonians is not a peculiar circumstance. Bartram represents the Muscogulges and Cherokees of North America, inhabiting between 31° and 35° of North latitude, as taller than Europeans; many being above six feet, and few under five feet eight or ten inches. (Travels, p. 482). The Caffrees, according to Barrow, are "tall, robust, and muscular, and distinguished by a peculiar firmness of carriage; some of them were six feet ten inches, and so elegantly proportioned, that they would not have disgraced the pedestal of the Farnese Hercules. The accounts of a pigmy race, called Quimos or Kimos, in the interior of Madagascar, do not seem to be at all authentic. The Laplanders and Nova Zemblians, in Europe, the Samoieds, Ostiacs, Yakuts, and Tungooses in Asia, and the Greenlanders and Esquimaux of America, all, in short, who inhabit high northern latitudes, are short in stature, measuring from four to five feet; and they agree remarkably in other characters, although occupying such distant countries. This accordance must be explained by exposure to the same causes; living in a barren and inhospitable climate, and exposed equally to its rigour, feeling the same wants, and having the same means of gratifying them, should we not expect a similarity of stature, colour, countenance, &c.? It seems rather doubtful, whether the miserable Pescherais, who wander naked over the rocks of Terra del Fuego, are also diminutive; but Barrow informs us, that the Boshmen, who adjoin the Cape, scarcely ever exceed four feet nine inches.

Every one will immediately perceive, that the differences of stature in the human race are not equal to those occurring in different breeds of animals. The pigs taken from Europe into the island of Cuba have grown to twice their original size; and the cattle in Paraguay have experienced a great increase in this respect.

That climate possesses an influence, seems to be proved from the circumstance of the Laplanders and Hungarians, which differ so widely in stature and formation, having descended from a common source.

Physiological considerations render it probable, that food will be efficacious in increasing or diminishing stature. The Arees or nobles of Otaheite and the Society Islands exceed the other natives in stature and personal beauty; and this is ascribed by Forster to their enjoying a more copious and luxurious food. The use of ardent spirits is said to have diminished the size of the native Americans in some instances.

That the state of society and manner of life have great influence on the stature, may be proved, by comparing the present Germans with their ancestors, as described by the Roman authors. The ancient Germans lived chiefly on animal food, as milk and flesh: they were strangers to the use of wine and spirituous liquors; in time of peace, they were employed in the chase, free from those cares which so often agitate and oppress more civilized people. They refrained from the enjoyment of women till a late period; "Sera juvenum Venus eoque in exhausta pubertas." Hence they appear to have been of immense size and strength, and undaunted courage; "immanes animis et corporibus," is the forcible language of Pomponius Mela. Conring, after comparing all the accounts of the writers of those times, states their stature at six feet three inches; which equals that of the Patagonians, and certainly exceeds that of the modern Germans.

As the ancient Germans seem to have exceeded the stature of the moderns, so, if we may credit their philosophic describer, the cattle were distinguished in the contrary way, which is not, we believe, the case at present. "Pecorum fecunda, sed plerumque improcera. Ne armentis quidem suus honor, aut gloria frontis." Tacitus.

The observations of Barrow concerning the Caffres, whose superior stature we have just noticed, confirm our reasonings as to the effect of climate and manner of life. "The natives of Caffraria," says he, "if taken collectively, are perhaps superior in point of figure to the inhabitants of any other country on earth: they are indeed exempt from many of those causes, which in civilized society tend to debilitate and impede the growth of the human body. Their diet is perfectly simple, their exercise conducive to health, and the air which they breathe is salubri-

ous. Strangers to the licentious appetites which frequently proceed from a depraved imagination, they cheerfully receive the bounteous gifts of nature; and when midnight sways her ebon sceptre over the country,

"Sweetly composed the weary peasant lies,
Tho' through the woods terrific winds resound;
Tho' rattling thunder shakes the vaulted skies,
Or vivid lightning runs along the ground."

We must remember, that the stature of any tribe or nation will be gradually changed by inter-marriages with others, and that it can be preserved pure only by avoiding such intercourse. That hereditary disposition has great influence on the size of the body, is undeniably proved by numerous examples of families remarkable for their tallness or lowness of stature.

Faculties of the Mind. The different progress of various nations in general civilization, and in the culture of the arts and sciences, the different characters and degrees of excellence in their literary productions, their varied forms of government, and many other considerations, must convince us, beyond the possibility of doubt, that the races of mankind are no less characterized by diversity of mental endowments, than by those differences of organization which we have already enumerated and considered. Such, however, has been the effect of education, of laws, of peculiar habits and customs, and of the different forms of government, in modifying the mind and character of men, that we cannot now discern what should be ascribed to original difference, and what should be referred to the operation of these external causes. That climate will exert a powerful influence on the mind, may be very reasonably expected; and it has an analogous influence on the animal creation. We are informed, that the dog in Kamtschatka, instead of being faithful and attached to his master, is malignant, treacherous, and full of deceit. He does not bark in the hot parts of Africa, nor in Greenland; and in the latter country loses his docility, so as not to be fit for hunting.

Yet we are decidedly of opinion, that the differences of intellect are not sufficient, in any instance, to warrant us in referring a particular race to an originally different species; and we particularly protest against the sentiments of those, who would either entirely deny to the Africans the enjoyment of reason; or who ascribe to them such vicious, malignant, and treacherous propensities, as would degrade them even below the level of the brute. It can be proved most clearly, and the preceding observations will suffice for this purpose, that there is no circumstance of bodily structure so peculiar to the Negro, as not to be found also in other far distant nations; no character, which does not run into those of other races, by the same insensible gradations, as those which connect together all the varieties of mankind. We cannot but admire the reasoning and humanity of those, who, after tearing the African from his native soil, carrying him to the West Indies, and dooming him there to perpetual labour, complain that his understanding shews no signs of improvement, and that his temper and disposition are incorrigibly perverse, faithless, and treacherous. Let us, however, observe him in a somewhat more favourable state, than in those dreadful receptacles of human misery, the crowded decks of the slave-ship, or in the less openly shocking, but constrained and extorted, and therefore painful, labours of the sugar plantation. The acute and accurate Barbot, in his large work on Africa, says, "The blacks have sufficient sense and understanding, their conceptions are quick and accurate, and their memory possesses extraordinary strength. For, although they can neither read nor write, they never fall into confusion or error in the greatest hurry of business and traffic. Their experience of the knavery of Europeans has put them completely on their guard, in transactions of exchange: they carefully examined all our goods, piece by piece, to ascertain if their quality and measure are correctly stated; and shew as much sagacity and clearness in all these transactions, as any European tradesman could do." Of those imitative arts, in which perfection can be attained only in an improved state of society, it is natural to suppose that the Negroes can have but little knowledge; but the fabric and colours of the Guinea cloths are proofs of their native ingenuity; and, that they are capable of learning all kinds of the more delicate manual labours, is proved by the fact, that nine-tenths of the artificers in the West Indies are Negroes: many are expert carpenters, and some watch-makers. The travels of Barrow, Le Vaillant, and Mungo Park, abound with anecdotes honourable to the moral character of the Africans, and proving that they betray no de-

ficiency in the amiable qualities of the heart. The former gives us a most interesting portrait of the chief of a tribe: "His countenance was strongly marked with the habit of reflection; vigorous in his mental, and amiable in his personal qualities, Gaika was at once the friend and ruler of a happy people, who universally pronounced his name with transport, and blessed his abode as the seat of felicity." Alas! many European kings would appear to very little advantage by the side of this savage. The drawings and busts executed by the wild Boshmen, in the neighbourhood of the Cape, are praised by the same traveller, for their accuracy of outline, and correctness of proportion.

Instances are by no means wanting, of Negroes who have distinguished themselves in literature and the arts, when favoured by fortune with opportunities of education and improvement. Freidig in Vienna was a capital performer on the violin, and an excellent draftsman. Hannibal, a colonel of artillery in the Russian service, was very well informed in the mathematical and physical sciences; as also was Lislet, of the isle of France, who was made on that account a corresponding member of the French academy. Fuller, of Maryland, was an extraordinary example of arithmetical knowledge: being asked in company how many seconds a man had lived, who was seventy years and some odd months old, he gave the number in a minute and a half: on reckoning it, a different result was obtained; "you have forgotten the leap years," says the Negro: the necessary addition brought it right. A. W. Amo took the degree of doctor in philosophy at Wittenberg, in 1734, and produced two ingenious and well-written dissertations: and Vasa and Ignatius Sancho have distinguished themselves as literary characters in this country. Blumenbach, after mentioning these instances in his Beyträge zur Naturgeschichte, sarcastically observes, that entire and large provinces of Europe might be named, which had not furnished such good writers, poets, philosophers, and correspondents of the French academy; and he adds, that no savage people have given such strong indications of a capability of improvement, and even of scientific cultivation, as the Negroes; and consequently, that none can approach more nearly to the polished nations of the globe. Let us conclude, then, with the quaint, but humane observations of the preacher, who called the Negro "God's image, like ourselves, although carved in ebony."

We shall conclude the present article with giving the generic character of man; and a general description of the five varieties, into which the human race has been divided by Blumenbach.

Generic character: erect, two-handed; prominent chin. Teeth of uniform height in an unbroken series; the lower incisors perpendicular.

As we have shewn, on the one hand, that there is no circumstance of difference between the varieties of the human race, which does not appear in a still greater degree among animals, chiefly of the domesticated kinds, arising from the ordinary sources of degeneration; so there is no point, whether of colour, countenance, or stature, which does not pass by imperceivable gradations into the opposite character, rendering all these distinctions merely relative, and reducing them to differences in degree. Hence it is obvious, that any division of the varieties of the human race must be in a great measure arbitrary. For the same reason, one or two characters are not sufficient for determining the race, but an union of several is required; and even this is exposed to many exceptions in each variety.

1. *Caucasian variety*. White skin, red cheeks, brownish hair, head of a somewhat globular form; oval and straight face, with features moderately separate from each other, expanded forehead, narrow and rather aqueline nose, and small mouth: front teeth of both jaws perpendicular; lips gently turned out, and chin full and rounded.

It includes the Europeans (excepting the Laplanders, and rest of the Finnish race); the Western Asiatics, as far as the river Ob, the Caspian sea, and the Ganges; and the northern Africans.

The name of this variety is derived from Mount Caucasus, because in its neighbourhood we meet with the most beautiful race of men in the world, *viz.* the Georgians. From the accounts of numerous travellers, who all agree on this subject, we select the remark of Chardin: "The blood of Georgia is the finest in the East, and I may say in the world. I have not observed a single ugly countenance in that country in either sex; but have seen numerous angelic ones. Nature has bestowed on the women graces and charms, which we see in no other place. It is impossible to look at them without loving them. More

beautiful countenances, and finer figures, than those of the Georgian women, cannot even be imagined."

Various reasons conspire in inducing us to place the first families of men in this quarter; and this race forms a medium between the two following varieties. An argument on this subject arises from the white colour of the Caucasian race, which we should be disposed to consider as the primitive colour of men: since the white easily degenerates into the darker shades, while those, when once fixed, hardly change at all.

2. *Mongolian variety.* Olive colour; black, straight, strong, and spare hair; head of a square form; broad and flattened face, with the features running together; the glabella (interval between the eyebrows) flat and very broad; nose small and flat; rounded cheeks projecting externally; narrow and linear aperture of the eyelids; slight projection of the chin.

This includes the rest of the Asiatics, (excepting the Malays); the Finnish races of the colder parts of Europe, as the Laplanders, &c.; and the tribes of Esquimaux, extending over the northern parts of America, from Bhering's Strait to the extremity of Greenland.

The Mongolians, widely scattered over the continent of Asia, have generally, but erroneously, been included with some of very different origin and formation, under the name of Tartars; whereas the last-mentioned tribes, properly so called, belong to the first division of the human race. The Calmucks, and other Mongolian nations, which overran the Saracen empire, under Zenghis Khan, about the middle of the thirteenth century, and had entered Europe, are described in the "Historia Major" of Matthew Paris under the name of Tartars, whereas that name (or, as it should be spelled, Tatars) properly belongs to the western Asiatics, who had been vanquished by the Monguls. The error, however, arising from this source, has been propagated down to the present day, so that in the works of the most approved naturalists, as Buffon and Erxleben, we find the characters of the Mongolian race ascribed to what they call the Tartars.

The Tartars indeed are connected by the Kirgises, and neighbouring tribes, to the Monguls, in the same way as the latter are joined by the inhabitants of Thibet to the Indians; by the Esquimaux, to the Americans; and by the Philippine islanders, with the Malays.

3. *Ethiopian variety.* Black skin; black and woolly hair; head narrow, and compressed laterally; arched forehead; cheekbones standing forwards; prominent eyes; thick nose, confused with the extended jaw; alveolar arch narrow, and elongated anteriorly; the upper front teeth projecting obliquely; the lips, and particularly the upper one, thick; the chin receding; knees turned in in many instances. The remaining Africans, besides those classed in the first variety, belong to this.

Several of the observations in the preceding parts of this article shew how ill-founded is the opinion of those who consider the Africans as a distinct species, merely because his colour, a very striking character, is so unlike our own. The observation, that Negroes resemble monkeys more than those of the other varieties, is true in the same sense as it might be said, that the variety of the pig, which has a solid hoof, resembles the horse more nearly than other pigs; but the comparison itself is not a very important one, since it has been made, even by accurate observers, of several nations in the other varieties; as the Laplanders, Esquimaux, Caaiguas of South America, the inhabitants of the island Mallicollo, &c.

4. *American variety.* Red colour; black, straight, strong, and thin hair; short forehead; deep eyes; nose somewhat flattened, but prominent; a broad, but not flattened face, with the cheeks standing out, and the different features projecting distinctly and separately; the forehead and vertex often deformed by art. This variety includes all the Americans, with the exception of the Esquimaux.

Several idle tales have been propagated concerning the distinguishing characters of this race. Some have denied the existence of a beard in the male, and that of the menstrual discharge in the female; and others have ascribed an uniform colour and countenance to all the inhabitants of this vast continent. The concurring testimonies of all accurate modern travellers prove clearly that the Americans have naturally beards; that it is a very general custom with them, as it has been with several Mongolian and Malay tribes, carefully to eradicate this excrescence; but that various hordes in different parts of the continent preserve it as other men do. From a cloud of unanimous reports on this subject we select the following statement of the immortal Cook, respecting the natives of Nootka Sound. "Some have no beards at all, and others only a thin one on the point of the chin. This does not arise from an original deficiency of hair in those parts, but from their plucking it out by the

roots: for those who do not destroy it have not only considerable beards on every part of the chin, but also whiskers, or mustachios, running from the upper lip to the lower jaw obliquely downwards." (Last Voyage, vol. ii. p. 240.) The observation concerning the menses has arisen from the women being secluded during their appearance. The redness of the skin is not so constant, but that it varies in many instances towards a brown, and approaches likewise in some temperate situations to the white colour. Cook states, that the natives about Nootka Sound are little inferior in fairness to Europeans; and Bouguer makes the same observation of the Peruvians on the Andes. It is also fully ascertained at present, that the Americans possess the same varieties of feature which are observed in the other races.

5. *Malay variety*. Brown colour; hair black, soft, curled, and abundant; head moderately narrow, and forehead slightly arched; nose full and broad towards the apex; large mouth; upper jaw rather prominent; the features, when viewed in profile, projecting and distinct. The inhabitants of the peninsula of Malacca, of the South Sea, Ladrone, Philippine, Molucca, and Sunda islands, are arranged under this division.

As the Americans in their national characters hold the middle place between that middle variety of the human race, which we have called the Caucasians, and one of the extremes, *viz.* the Mongolians; so the Malay forms the connecting link between the Caucasian and the Ethiopian. The name of Malay is given to it, because most of the tribes which it includes, as those which inhabit the Indian islands near Malacca, the Sandwich, Society, and Friendly islands, also those of Madagascar, and thence to Easter island, use the Malay language.

The inhabitants of such various and distant countries may reasonably be expected to differ considerably in elegance of form, and in other circumstances of bodily organization. Hence some have even described two races in the island of Otaheite; one of light colour, tall stature, and countenance scarcely distinguishable from the European: the other of moderate stature, with the colour and countenance of the Mulatto, crisp hair, &c. The latter, therefore, constitutes an intermediate gradation, passing towards the inhabitants of the western islands of the Pacific Ocean. And of these the men of the New Hebrides form a link of connection with those of New Guinea and New Holland, which are so very similar to the Ethiopian variety, that they might be arranged without impropriety under that division.

The varieties which we have just stated are so many proofs of that pliancy so wisely bestowed by nature on the human constitution, to enable it to adapt itself to every clime. Thus the goodness of the Creator appears, in forming the whole world for man, and in opening to him every opportunity of enlarging his habitation, and multiplying his scientific acquirements; instead of confining him, like the inferior animals, to a bounded range. He is completely unrestrained in the choice of his dwelling, by considerations of air, temperature, &c.; and consequently far exceeds all other parts of animated creation in extension over the surface of the globe. Gmelin experienced cold of 126° below 0 of Fahrenheit's scale, at Jeniseik, in Siberia. The Greenlander lives, and follows his occupations, where the vegetable creation can no longer subsist, and where the snow-bunting, with the polar fox and bear, half frozen, and perishing with hunger, hide themselves in holes of the ground. On the contrary, in Senegal, the thermometer mounts sometimes to 117° above 0; and a natural warmth of 125° has been experienced. In short, man lives in every part of the known world (excepting some unexplored northern countries, and a few remote southern islands), from Greenland to Terra del Fuego, from Spitzbergen to the Cape, from the 80th degree of north to the 58th of south latitude.

MANDAMUS, is a writ issuing in the King's name, out of the Court of King's Bench, and directed to any person, corporation, or inferior court of judicature, commanding them to do some particular thing, as appertaining to their office and duty.

A writ of mandamus is a high prerogative writ, of a most extensive remedial nature, and may be issued, in some cases, where the injured party has also another more tedious method of redress, as in the case of admission or restitution to an office; but it issues in all cases where the party has a right to have any thing done, and hath no other specific means of compelling its performance. And this general jurisdiction and superintendancy of the King's Bench over all inferior courts, to restrain them within their bounds, and to compel them to execute their jurisdiction, whether such jurisdiction arises from a modern charter, subsists by

custom, or is created by act of parliament; yet being in *subsidium judiciæ*, has of late been exercised in a variety of instances.

It is grounded on a suggestion by affidavit of the party's own right, and the denial of justice below. It is sometimes granted upon a rule to shew cause only, but sometimes it is peremptory in the first instance. When it issues to do the thing, or shew cause, an action lies for a false return, if there be in fact such false return; but the Court will not itself try the truth of the return in the first instance. It is usually applied to the restoring of officers in corporations, or to electing new ones, where others have been wrongfully elected. See statutes 9 Anne, c. 20, and 12 George III. c. 21. It is a writ of very general application, and great utility, and may be said generally to lie where any person by his office has a clear duty to perform, and neglects to perform it, and the Court can order him to do the act required.

MANDRAKE, a species of the Atropa, from which a reference has been made, possesses a long taper root, resembling the parsnep: running three or four feet into the ground; immediately from the crown of the root arises a circle of leaves, at first standing erect, but when grown to their full size, they spread open and lie upon the ground; these leaves are more than a foot in length, and about five inches broad in the middle, of a dark-green colour, and a fœtid scent: among these come out the flowers, each on a scape, three inches in length; they are five-cornered, of an herbaceous white colour, spreading open at top like a primrose, having five hairy stamens, and a globular germ supporting an awl-shaped style, which becomes a globular soft berry, when full-grown as large as a nutmeg, of a yellowish green colour, and when ripe full of pulp.

Many singular facts are related of this plant, among which we select the following: the roots have been supposed to bear a resemblance to the human form, and are figured as such in the old herbals, being distinguished into the male with a long beard, and the female with a prolix head of hair. Mountebanks carry about fictitious images, shaped from roots of bryony and other plants, cut into form, or forced to grow through moulds of earthen ware, as mandrake roots. It was fabled to grow under a gallows, where the matter falling from the dead body gave it the shape of a man; to utter a great shriek, or terrible groans, at the digging up; and it was asserted, that he who would take up a plant of mandrake, should in common prudence tie a dog to it, for that purpose; for if a man should do it himself, he would surely die soon after. See Martyn's botany.

MANDREL, a kind of wooden pulley, making a member of the turner's lathe, of which there are several kinds, as the flat mandrels, which have three or more little pegs or points near the verge, and are used for turning flat boards on; the pin mandrels are those which have a long wooden shank to fit into a large hole made in the work to be turned; hollow mandrels are those hollow of themselves, and used for turning hollow work; screw mandrels for turning screws, &c.

MANETTIA, in botany, so named from Xavier Manetti, Prefect of the Botanic Garden at Florence; a genus of the Tetrandria Monogynia class and order. Natural order of Contortæ. Rubiaceæ, Jussieu. Essential character: calyx eight-leaved; corolla four-cleft; capsule inferior, two-valved, one-celled; seeds imbricate, orbicular, with a central seedlet. There are three species.

MANGANESE, in chemistry, a substance that has long been employed in the manufacture of glass, on account of its property of depriving that substance of its colour. From its appearance it was called black magnesia, or manganese. It was considered as an ore of iron, because it was found combined with the oxide of that metal. Bergman and Scheele gave an accurate description of its nature and properties. It is generally found in the state of an oxide, either white, or black, or red. The white contains the smallest proportion of iron and of oxygen. This ore soon tarnishes in the air by absorbing oxygen. The red contains more iron than the white, and is crystallized. The black or the brown ore is frequently crystallized like the red. Manganese is procured in the metallic state, by reducing the oxide to powder, and forming it into a paste with water. It is then exposed to a strong heat, not less than 160° of Wedgwood, with charcoal, and the metal, after a time, is found at the bottom of the crucible, or in the midst of the scoriæ in small globules, which amount to nearly one-third of the manganese employed. Manganese, in the metallic state, is of a greyish white colour, with considerable brilliancy, and of a granular texture. The specific gravity is 6.85. It is hard as iron; is one of the most brittle and most infusible of the metals. When exposed to the air it is quickly tarnished, and at length falls

into powder, which is found to have acquired considerable addition to its weight. But when heated in the open air, it passes more rapidly through the different changes of colour in proportion as it combines with oxygen, to the absorption of which these changes are owing: hence manganese, like some other metals, combines with different portions of oxygen, forming with it different oxides. The different coloured oxides are combined of manganese and oxygen in the following proportions:

	White Oxide.	Brown or Red Oxide.	Black Oxide.
Manganese . .	80	74	60
Oxygen	20	26	40
	100	100	100

From the black, which is most abundant in oxygen, the chemists usually obtain what they use in their experiments. The black is evidently the metal at the maximum of oxydizement, the white is the one at the minimum. Manganese does not enter into combination with azote, hydrogen, or carbon. By means of charcoal the oxide is reduced, by being deprived of its oxygen. Phosphorus combines very readily with manganese, forming a phosphoret. It may likewise be made to combine with sulphur, forming a sulphuret. It enters into combination with the acids, and forms salts with them. These salts may be decomposed by the alkalies, which throw down precipitates of a yellow or reddish colour. None of them are decomposed by any of the other metals, which shews the strong affinity of manganese to oxygen. The pure alkalies favour the oxydation of manganese, and the decomposition of water, because they combine readily with this oxide. When the black oxide is exposed to heat, with twice its weight of dry soda or potash, a compound is formed of a dark green colour, which is soluble in water. During the solution, this substance exhibits rapid changes of colour, and on that account has been denominated the "mineral camelion." There is no action between manganese and any of the earths; but its oxide combines with them, and forms vitreous matters, which are of different colours, according to the degree of oxydation of the manganese, and its mixture with iron. The native black oxide of manganese is applied to several purposes. It is the substance from which oxygen can be most economically obtained, large quantities of which are consumed in the formation of the oxy-muriatic acid employed in the art of bleaching. It is used in glass-making, to remove from the substance the green colour which is derived from the oxide of iron. The theory of its action is thus explained: iron, in a low state of oxydizement, gives to glass a green tinge, while, if it be at a high degree of oxydizement, it either does not enter into fusion with the ingredients of the glass, or at least does not communicate any colour. Manganese, in the state of black oxide, gives a violet colour, but reduced to the white oxide the glass is colourless. In adding, therefore, the black oxide to glass, while it yields its oxygen to the iron, which it thus brings to a high state of oxydizement, it passes itself to the state of white oxide, and thus each metal is in that state in which it does not communicate colour. The black oxide is also useful, probably by consuming the carbonaceous matter and other substances present in the materials which are susceptible of oxydizement. In large quantities it is used in the composition of ornamental glass, to give a purple colour. It is likewise employed to give a black colour to earthen ware, a quantity of it being mixed with the composition before it is baked.

MANGIFERA, in botany, *mango-tree*, a genus of the Pentandria Monogynia class and order. Natural order of Terebintaceæ, Jussieu. Essential character: corolla five-petalled; drupe kidney-form. There are three species, of which M. indica, mango-tree, is the most remarkable; it is a large spreading tree; the wood is brittle, and used only for indifferent works; the bark becomes rugged by age; the leaves are seven or eight inches long, and about two broad, terminating in points, having several transverse parallel opposite ribs; the flowers are produced in loose bunches at the ends of the branches; the fruit of this tree, when fully ripe, is yellow and reddish, possessing a fine agreeable juice; some are full of fibres, the juice runs out of these on cutting; but those without fibres are much the finest, they cut like an apple, and are esteemed a very wholesome fruit; excepting pine apples, they are preferable to any other in India: in Europe we have only the unripe fruit brought over in pickle.

MANIS, in natural history, a genus of Mammalia, of the order Bruta. Generic character: no teeth; tongue round and

extensile; mouth narrowed into a snout; body covered above with moveable bony scales. These animals greatly resemble the ant-eater, and feed like that creature by protruding their tongues into the nests of various species of insects, and retracting them with inconceivable suddenness, with their prey attached to the tip. There are three species. M. tetradactyla, the long-tailed manis, has a tail more than twice the length of its body, and is often, in the whole, seen five feet long. Its colour is a dark-brown, with a tinge of yellow, and it displays a very brilliant gloss. It is perfectly covered, except on the belly, with large scales resembling the substance of horn, and which constitute a complete defence for it against its enemies, on whose attack it rolls itself up into a form very nearly globular, presenting on every side impenetrable armour. It is a native of India.

Manis pentadactyla, the short-tailed manis. This is much thicker and shorter than the former, and is covered with scales still thicker and stronger. It is found in many parts of India, and, according to some writers, in Africa, particularly in Guinea. It moves with great slowness, but on imminent danger of attack, rolls itself up with the compactness of a ball, and defies, in this state, the attempts even of some of the larger beasts of prey. It is called in some parts of India the thunderbolt, from the extreme hardness of its scales, which are said to elicit fire from iron, like a flint; and in other parts it is named the stone-vermin, a quantity of stones being generally found in its stomach, supposed to be swallowed by it for the purpose of digesting its food. It frequents marshy and woody places, and lives almost entirely on insects, particularly on ants. It has been seen of the length of even six feet. See Mammalia, Plate XV. fig. 5.

MANISURIS, in botany, a genus of the Polygamia Monoecia class and order. Natural order of Gramina, or Grasses. Essential character: hermaphrodite calyx; glume two-valved, one-flowered, outer valve emarginate at the top and sides; corolla less than the calyx; stamens three; style bifid. Male as in the hermaphrodites; but with the flowers in the lower side of the same spike, standing out more. There are two species, *viz.* M. myurus, and M. granularis natives of the East and West Indies.

MANNA, the food given by the Almighty to the children of Israel in the wilderness, is the concrete juice of the fraxinus ornus, or flowering ash. The tree is a native of the southern parts of Europe, particularly Sicily and Calabria. Many other trees and shrubs likewise emit a sweet juice, which concretes upon exposure to the air, and may be considered of the manna kind. In Sicily there are three species of fraxinus cultivated for the purpose of procuring manna, and are planted on the declivity of a hill with an eastern aspect. It is full ten years before these trees bear any quantity of manna; it then exudes spontaneously; but to obtain it more copiously, incisions are made through the bark by means of a sharp crooked instrument; and the season for performing this is in the middle of the summer.

MANOMETER, or Manoscope, an instrument to show or measure the alterations in the rarity or density of the air. The manometer differs from the barometer in this, that the latter only serves to measure the weight of the atmosphere, or of the column of air over it: but the former, the density of the air on which it is found; which density depends not only on the weight of the atmosphere, but also on the action of heat and cold, &c. Authors, however, generally confound the two together; and Mr. Boyle himself gives us a very good manometer of his contrivance, under the name of a statical barometer, consisting of a bubble of thin glass, about the size of an orange, which, being counterpoised when the air was in a mean state of density, by means of a nice pair of scales, sunk when the atmosphere became lighter, and rose as it grew heavier. Other kinds of manometers were made use of by Colonel Roy, in his attempts to correct the errors of the barometer. "They were," says he, "of various lengths, from four to upwards of eight feet: they consisted of straight tubes, whose bores were commonly from one-fifteenth to one-twenty-fifth of an inch in diameter. The capacity of the tube was carefully measured, by making a column of quicksilver, about three or four inches in length, move along it from one end to the other. These spaces were severally marked, with a fine-edged file, on the tubes; and transferred from them to long slips of pasteboard, for the subsequent construction of the scales respectively belonging to each. The bulb, attached to one end of the manometer at the glass-house, was of the form of a pear, whose point being occasionally opened, dry or moist air could be readily admitted, and

the bulb sealed again, without any sensible alteration in its capacity. The air was confined by means of a column of quicksilver, long or short, and with the bulb downwards or upwards, according to the nature of the proposed experiment. Here it must be observed, that, from the adhesion of the quicksilver to the tube, the instrument will not act truly, except it be in a vertical position; and even then it is necessary to give it a small degree of motion, to bring the quicksilver into its true place, where it will remain in equilibrio, between the exterior pressure of the atmosphere on one side, and the interior elastic force of the confined air on the other. Pounded ice and water were used to fix a freezing point on the tube; and by means of salt and ice, the air was further condensed, generally four, and sometimes five or six degrees below zero. The thermometer and manometer were then placed in a tin vessel among water, which was brought into violent ebullition; where, having remained a sufficient time, and motion being given to the manometer, a boiling point was marked thereon. After this the fire was removed, and the gradual descents of the piece of quicksilver, corresponding to every twenty degrees of temperature in the thermometer, were successively marked on a deal rod applied to the manometer. It is to be observed, that both instruments, while in the water, were in circumstances perfectly similar; that is to say, the ball and bulb were at the bottom of the vessel. In order to be certain that no air had escaped by the side of the quicksilver during the operation, the manometer was frequently placed a second time in melting ice. If the barometer had not altered between the beginning and end of the experiment, the quicksilver always became stationary at or near the first mark. If any sudden change had taken place in the weight of the atmosphere during that interval, the same was noted, and allowance made for it in afterwards proportioning the spaces. Long tubes, with bores truly cylindrical, or of any uniform figure, are scarcely ever met with. Such, however, as were used in these experiments, generally tapered in a pretty regular manner from one end to the other. When the bulb was downwards, and the tube narrowed that way, the column of quicksilver confining the air, lengthened in the lower half of the scale, and augmented the pressure above the mean. In the upper half, the column being shortened, the pressure was diminished below the mean. In this case, the observed spaces both ways from the centre were diminished in the inverse ratio of the heights of the barometer at each space, compared with its mean height. If the bore widened towards the bulb when downwards, the observed spaces, each way from the centre, were augmented in the same inverse ratio; but in the experiments on air less dense than the atmosphere, the bulb being upwards, the same equation was applied with contrary signs; and if any extraordinary irregularity took place in the tube, the corresponding spaces were proportioned both ways from that point, whether high or low, that answered to the mean. The observed and equated manometrical spaces being thus laid down on the pasteboard containing the measures of the tube; the 212° of the thermometer, in exact proportion to the sections of the bore, were constructed alongside of them: hence the coincidences with each other were easily seen; and the number of thermometrical degrees answering to each manometrical space, readily transferred into a table prepared for the purpose."

MANOR, was a district of ground held by lords or great personages, who kept in their own hands so much land as was necessary for the use of their families, which were called demesne lands, being occupied by the lord, or *dominus manerii*, and his servants. The other lands they distributed among their tenants, which the tenants held under various services. The residue of the manor being uncultivated, was termed the lord's waste, and served for common of all pasture to the lord and his tenants. All manors existing at this day must have existed as early as King Edward I., and must have a Court Baron.

MANTELETS, in the art of war, a kind of moveable parapets, made of planks about three inches thick, nailed one over another, to the height of almost six feet, generally cased with tin, and set upon little wheels, so that in a siege they may be driven before the pioneers, and serve as blinds to shelter them from the enemy's small shot.

MANTICORA, in natural history, a genus of insects of the order Coleoptera: antennæ filiform, the joints cylindrical; four feelers, filiform; thorax rounded before, emarginate behind; head projecting; mandibles exserted; shells united

without wings. There is but a single species, *viz.* M. maxillosa, that inhabits the Cape of Good Hope.

MANTIS, in natural history, a genus of insects of the order Hemiptera. Head unsteady; mouth armed with jaws; feelers filiform; four wings, membranaceous, convolute, the under ones plaited; fore legs compressed, serrate or toothed beneath; armed with a single claw and lateral-jointed process; the four hind ones smooth, and formed for walking; thorax (usually linear) elongated, and narrow. There are upwards of sixty species: the chief is M. oratoria, or camel-cricket, which is found in the southern parts of Europe, and is entirely of a beautiful green colour. It is nearly three inches in length, of a slender shape, and in its general sitting posture, is observed to hold up the two fore legs, as if in the act of devotion: hence it has been regarded as sacred, and a notion has prevailed, that a traveller, having lost his way, would be safely directed, by observing the quarter to which the animal pointed when taken in the hand. This insect is of a predacious disposition, living on smaller insects, which it watches for with great anxiety; it is also quarrelsome, and when kept with others of its own species in a state of captivity, they will attack each other with the utmost violence, till one is destroyed. The conqueror devours his antagonist. M. precaria is said to be the idol of the Hottentots.

MANUFACTURE *of cotton.* To this article we referred from the word COTTON, having been deprived, by accident, of the information which we are now enabled to lay before the public on this interesting part of English manufactures.

We shall begin with the description of the fabrication of cotton yarn by the spinning jenny, both because of its more ancient use, and as it leads best to the general knowledge of the manufacture.

Preparation of the Cotton-wool. The raw cotton is imported in large bales, compressed very closely together by engines, and contains the seeds of the plant mixed through it in considerable quantities, together with more or less foreign matter, from which it must be freed; for this purpose, it is in general sufficient to beat it well with sticks, by which it undergoes a process similar to the threshing of corn. This is usually performed on a frame, similar to a table, the upper surface of which is formed by small cords stretched tightly across, nearly in contact, the elasticity of which assists the operation, while their intervals afford a free passage for the separation of the seeds and other substances in the cotton. In this process the cotton recovers its original volume, and loses the hard consistence into which it had been pressed in the bales.

Picking Engine. An engine has been contrived to render this operation more perfect, which is used in some manufactories: this consists of two revolving fluted rollers of metal, about an inch in diameter, and sixteen inches long, placed horizontally one over the other; a kind of comb of steel in the same direction moves before these rollers, with a quicker motion up and down, very close to the rollers, so as to catch and draw out the cotton as it passes forwards between them: underneath an oblong sieve of wire moves back and forwards horizontally, which catches the cotton as it falls from the comb, and frees it from the loose seeds and other matters: above, a sort of frame, like a table, lies behind the rollers, over which an endless cloth is contrived to pass continually, so as to come in one part very close to the rollers; on the upper surface of this cloth the cotton is spread by hand evenly, and thus is brought forward by degrees to the rollers, which deliver it to the comb, as already described.

Another engine of coarser operation is sometimes used previous to the above. This is formed by an oblong roller, three or four feet long, and about fourteen inches diameter, having longitudinal rows of spikes, of three inches long, at intervals of four or five inches, projecting from its surface. This roller revolves within a hollow cylinder, furnished in like manner with rows of spikes projecting inwards, so that the spikes of the internal roller may pass between them: both roller and case are formed usually of bars of wood, so as to leave free space for the cotton to pass, and the dirt to fly out.

Where these engines are not used, or when they are not sufficiently perfect to completely free the cotton from its seeds and foreign matters, the cotton wool is afterwards carefully picked by women and children, who remove whatever matters might remain in it after the former operations.

When the picking is completed, the cotton next undergoes the process of washing with soap, which not only cleanses it from dirt adhering to its fibres, but it is thought has also a sort of chemical action on it, in making the fibres

more tortuous and spiral, by which in a great measure the yarn formed from it acquires that elastic softness, which peculiarly distinguishes it from that spun in mills, which latter does not usually undergo this operation, and which fits it so well to form the weft of cotton cloth, while the superior firmness and hardness of the mill-twist qualifies it better for the part of the warp for which it is generally employed.

After being thus washed, the cotton is next carried to the press, where most of the water which it has imbibed is forced out of it: in this operation it is generally put into a strong wooden box, perforated with holes at every side, and open at top; a wooden cover is then put over it, sufficiently small to enter the box; the whole being then put into the press, the cover is forced down by a wooden screw. Nothing made of iron should be used about the cotton while it is wet, as it might impart a stain hard to be removed.

When the cotton is sufficiently pressed, it is spread on canvass, or railed wooden frames, and brought to the stove to be dried.

The stove consists of a chamber, of size proportionate to the work to be done in it, which is usually arched over with brick, and separate from the other buildings of the cotton factory, to prevent accidents by fire; a flue of cast-iron runs through the middle of this chamber, a little above the floor, from a fire place, which opens outside. In some stoves, inverted pots, or metallic cylinders, are fixed at intervals along the flue, with which they communicate beneath; wooden supports are placed round the sides of the stove, to sustain the frames on which the damp cotton is spread, which is left to remain here till it is thoroughly dry. As the stove may be constructed in various manners, without any material difference in its performance taking place, it is probable that many other constructions are used in different places; but the one described is of a kind in very general use, and has no very obvious defect. It is probable a stream of heated air conveyed through the stove might be an improvement, tending to accelerate the drying process; as it is very obvious, that when the air contained in the stove becomes loaded with moisture, it cannot absorb that of the cotton very readily. Double doors should also be added to stoves, with a small space between them; and one door should always be shut again before the other was opened, to prevent the cooling of the stove, by the whole mass of heated air passing out at once, which must frequently take place in stoves with single doors.

Carding Engine for Jenny-spinning. When the cotton is sufficiently dry, the next operation which it undergoes is that of carding. This is performed on an engine which has now been brought to great perfection, of which, and of the manner in which it is used, the following is a description. The cotton is first spread on a feeding cloth, disposed in the same manner as that already described for the same purpose in the picking engine; two small rollers, about an inch in diameter, take up the cotton between them, as it successively approaches them on the revolving cloth, and deliver it to a roller of from twelve to eighteen inches diameter, according to the size of the engine, covered with cards of the fineness proper for cotton: (cards for the operation of carding cotton or wool by hand, being used in most towns and villages, need not be described here, and will also be found under their proper head): from this roller the cotton passes to another of about the same size, from whence it is delivered to the great carding roller, which is from two to three feet in diameter: about the upper half of this roller several small rollers are placed, of three or four inches diameter, between which and the great roller the cotton is carded, as well as between those of a larger size: another roller, of from twelve to eighteen inches diameter, takes the cotton from the large roller, and is again stripped of it by a kind of comb, with very short teeth of iron, which, moving up and down before the roller, strikes the cards in its descent in the direction of their teeth, by which the cotton is separated in a fine thin sheet, like a fleece, in which it passes between a smooth roller (which is mostly covered with fine paper), and a hollow semi-cylinder, that form it into oblong rolls, similar to those made by hand-carding, but much longer: on the surface of the smooth roller are small projections, parallel to the axis, at the distance of four or five inches from each other; which, rolling the cotton between them and the semi-cylinder beneath, produce the effect described. These projections are formed in many engines by whipcord stretched tightly across in the proper places, before the paper is pasted on, which covers both them and the roller.

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When the cotton is thus formed into rolls, it falls into a receptacle, whence it is taken to be slubbed.

It is to be understood, that the operation of carding performed by the several rollers described, is effected by each successively moving faster than the one behind it, and of course slower than the one before it, with the exception of the small rollers placed above the great roller, which move with an uniform velocity, and all much slower than the large roller. In some carding engines, formerly, a good deal of the motions were performed by toothed wheels and pinions, but of late years they are effected by bands, or straps, which produce a much more equable and steady movement. The large rollers are generally made by placing two or more wheels of cast iron on one axle, the circumferences of which wheels are cased with wood, which is attached to them by screws or rivets: the smaller rollers are formed in a similar manner on wooden disks; but all are made hollow, to prevent warping.

Slubbing. When the cotton is carded, the long rolls into which it is formed are next drawn out into a thick coarse thread, of loose texture, and but little twisted, called the slubbing. This operation is generally performed by hand, on the common hand wheel, which is similar to that used for spinning wool, but of a smaller size. Engines have been contrived, by which a number of slubbings could be drawn out together; but the hands required for joining the rolls of cotton in succession, and for other purposes about those engines, were found to be so many, that very little, if any, saving was made by those machines.

Robing. The slubbing coiled into conoidal rolls, called cops, are next brought to the engine called the robing billy, by which it is drawn out into a finer thread, of the same loose texture as before, receiving at the same time a little more twist.

The Robing Billy. This machine is contrived to give circular motion to a number of spindles, and at the same time draw out the slubbing which is attached to them by a finer thread. The spindles are placed in a frame, so as to stand nearly perpendicularly at about four inches from each other; their lower extremities turn in sockets, and small collars of brass sustain them about half way up: their upper halves project above the frame: to their lower parts are attached small pullies, or whirls, from whence bands pass to a horizontal cylinder of about six inches diameter, a little longer than the row of spindles, which is placed before them at a lower position, and which gives motion to all the spindles together, when it is turned round. This cylinder is now almost universally made of tin plate; wooden ones of the same dimensions, however carefully made, have been found liable to warp and lose their proper shape. To prevent the bands from slipping, coarse paper is pasted over the tin, which answers the purpose very effectually. The cylinder receives its motion from a wheel, (like the large wheel used in spinning wool by hand, and of the same dimensions), with which it communicates by a band: this wheel is turned by the hand directly, by means of a winch. In front of the spindles, about a foot higher than their tops, a long spar of deal is supported at each extremity by a pair of small wheels, or sheeves, which run on the sides of the frame in a kind of grooves, so as to admit of the spar being moved back and forwards about six or seven feet, in a horizontal position, without varying from its parallelism to the row of spindles: the bottom of this spar is formed into oblong narrow grooves, into which projecting parts from a lower spar suspended beneath it fit accurately. This lower spar is confined by a sort of staples, so as to admit only of a motion up and down of a few inches below the upper spar, along with which it is drawn back and forwards: the up and down motion is given by a number of small cords at about three feet asunder, which pass from it, over small pulleys in the substance of the upper spar, to a thick wire that lies above it; which wire is moved by a cord going round a pulley of about six inches diameter, supported at the middle of the upper spar: to this pulley an handle is fixed, which, on being pressed down over a spring clasp, raises up the lower spar close to the upper one, and retains it in that position: when the spring clasp is pressed back from the handle, the weight of the lower spar causes it to fall down clear of the upper one. The use of this arrangement of the two spars, is to hold fast the slubbings, which are passed between them on to the spindles. The cops of slubbings are supported on a frame, which lies below the moveable spars; small rods pass through them, and through holes in the frame, which sustain them in an upright position, at about the same distance from each other as the spindles.

When the robing billy is worked, the slubbings are first drawn between the moveable spars, and each fastened to its

corresponding spindle: a sufficiency of length of the slubbings is left between the spars and the spindles, to allow for five or six feet of robing to be drawn out of each, which is regulated by a mark on the frame, that shews when the moveable spars going from the spindles have come to the proper position: the spars are then closed by pressing down the handle under the clasp, the spindles are put in motion by turning round the large wheel, and at the same time the moveable spars are drawn back gently: by this means, as the slubbings are drawn out, they get proportionally more twist, so as to keep them from breaking; and when they are drawn to the intended extent, by the spars being moved back to the extremity of their supports, a few turns of the wheel gives them all the twist that portion of them is intended to have. The robings now formed between the spars and the spindles, are guided to that part of their respective spindles where they are to remain; and the spindles being again put in motion, while the spars are pushed forwards towards them; the part formed of the robings are by this means rolled upon the spindles. The handle is then released, the lower spar falls down, the spars are drawn back to the mark, which shews that the proper length of slubbing has passed between them; the spars are again closed, and the operation repeated as before described. The robings are guided to the parts of the spindles where they are to be coiled up, by a long horizontal slip of deal, which is supported over them close to the front of the spindles by a light frame, hung on two pivots, that admit of its moving the length of the spindles up and down: a cord is stretched from this frame, near the pivot, along one of the supports of the moveable spars, and passes between three small pulleys at the extremity of the spar: two of the pulleys being at the side of it next the spar, and the middle pulley being outside: this last pulley is fastened to a slide, which is drawn back by a string that runs along the spar to its centre, where it passes over a grooved segment of a small wheel, with a small projection; which, being pressed down by the finger, draws the cord in, which causing the stretched cord to contract in length between the pulleys, forces the deal slip down on the robings, and guides them to the parts of the spindles where they are to remain: a small counterpoise draws off the slip, when the finger is removed, and restores this part of the apparatus to its first position.

Of Spinning, and the Spinning Jenny. When the robings are finished, they are brought to the spinning jenny, to complete the spinning. The spinning jenny is an engine on the same principle as the robing billy, and only differs from it in having smaller spindles, more in number, and closer together; the cops of robings are placed in it, as those of slubbings are in the billy, and by a similar management and operation are drawn out into the required fineness, and receive the degree of twist which forms them into cotton yarn.

Reeling. The cotton yarn, when taken from the jenny, is reeled, to ascertain its degree of fineness, and then laid by with others of the same sort: the reel used is a small wheel reel, which denotes the completion of the hank, or given number of yards, by a spring that slaps against its frame at that instant: its machinery is the simplest used, and not different materially from the wheel reels common in other manufactures.

The cotton yarn spun on jennies is almost solely used for weft, which from its superior softness it is peculiarly fitted for, which softness is indispensably requisite for some fabrics. As yet no way has been found of forming yarn by mill spinning of the same quality in this respect, and therefore the mill-yarn is almost entirely appropriated for warp. This material difference originates in the carding, which in that for the jennies lays the fibre of the cotton across the roll, while the carding engine for the mill-spinning lays the fibre longitudinally, in the direction in which it is afterwards spun, as will be more plain from the following description of this operation.

Of Mill Spinning. The cotton for mill spinning is cleared and beaten in a similar manner to that for jenny spinning, but is not washed or stoved; after it is judged to be sufficiently clean, it is brought to the carding engine.

Mill Carding Engine. The principles on which this engine is constructed, are the same as those on which the carding engine for jenny spinning is formed: the great point in which they differ is, in the manner in which the carded cotton is taken from them, which, in the mill engine, is so as to form an entire flake, or continued sheet, of the breadth of the last cylinder; the cards on this cylinder are generally formed of long narrow stripes, about an inch and a half broad, and are put on round it spirally, by which means there are no joinings in the longitudinal direction of the cylinder, of any considerable length. The carded cotton is struck

off this cylinder in the same way as from the other engine; but instead of being passed under the roller with longitudinal projections, to form it into rolls, it is drawn forward through a conical guide of tin, by two narrow wooden rollers, about six inches in diameter, that deliver it into deep and narrow tin vessels, in the form of a long ribband, about two inches in breadth. The mill engine, instead of the small carding rollers above the main cylinder, used in the jenny carding engine, has commonly narrow flat spars of deal, with cards attached to them, fixed at a proper distance from the principal cylinder. Toothed wheels and pinions are more used in the mill carding engine than bands; but that this is any improvement is doubtful, as in other parts of the machinery of mills, bands have been substituted for wheel work to advantage, and probably will be more so than they are now, as they work without causing that shaking motion which toothed wheels occasion in general, and which is both injurious to the evenness of the yarn, and the duration of the machinery. For toothed wheels, when in quick motion, act by a succession of percussions on each other, unless constructed with an accuracy as to the form of the teeth, that is very difficult to give to very small wheels, or unless the teeth are so numerous that several may come in contact at once, which in small wheels would cause them to be of too reduced a size, and too weak for mill work.

From the carding engine the long stripes of carded cotton are brought to engines consisting merely of two pair of small rollers, one pair of which moves faster than the other, and each pair of which are caused to press against each other with some force, either by weights or springs. Here two, three, or more of the stripes of carded cotton are drawn out together into another stripe, smaller than the first stripes, and this operation is repeated till the stripes attain that evenness which is so essential to the formation of good twist.

Of Mill Slubbing. The prepared stripes of carded cotton are then brought to the slubbing engine, where they are formed into a thread of very loose texture and little twist.

The slubbing engine consists of two pair of drawing rollers, between which the prepared stripes of carded cotton are drawn out to the required fineness, they then pass downwards into tin cylinders, which revolve with a velocity proportionate to the twist to be given; at the top of each cylinder two very small rollers are placed, which are made to turn round by bands passing down the sides of the tin cylinder, over small pullies, to a fixed wheel at bottom; these small rollers draw down the narrow stripes of cotton into the cylinders, and the centrifugal motion distributes them equally round the sides of each cylinder in a long hollow roll, which is taken out a door at the side of the cylinder, that is fastened with a hook and loop.

The slubbing is then rolled on bobbins, by hand, by children or women, by a very simple method, which both prevents its breaking, and causes it to be rolled on the bobbins with equal tightness in every part. The bobbin lies on the top of a narrow cylinder of wood, that just fits in between its two extremities, and which is about eight or ten inches in diameter: a wire is passed through the bobbin into the frame, each extremity of which has a vertical groove, that sustains it in its place; the cylinder is turned round by a winch, and as the slubbling rolls on the bobbin, still turns it round with equal velocity, as it is against the surface of the rolled cotton alone that it acts.

The Spinning Frames. When the slubbing is rolled on the bobbins, it is then prepared for spinning, and brought to the spinning frames for that purpose; where the bobbins are placed in rows above the frames in a sort of vertical rack prepared for them, and are kept in their places there, by thick wires which pass through them, on the points of which they revolve as the slubbing is drawn off them by the spinning apparatus, which consists principally of three pair of small rollers, which draw out the slubbing to the proper fineness, and of the fly and bobbin which gives it the due degree of twist, and rolls it up when spun. The three lower rollers are of steel, fluted or grooved longitudinally at small intervals, and are about an inch diameter. The upper rollers are of wood, with iron axles, and are covered first with cloth and then with glove leather, and rubbed well with chalk. Every steel roller is divided into as many intervals, of about an inch and a half long, as the number of threads to be drawn by it amount to, which is seldom more than six. The covered rollers are in lengths of two of those intervals, and each press on two of the slubbings; the extremities of their axis move in pieces of iron with vertical grooves, that admit them to press downward freely, but prevent all lateral motion; the middle of the axis, as well as

the ends, are turned in a lathe, and from it, by a hook, depends a weight that presses it against the steel roller that lies beneath. Springs are used also to give the same pressure, and where they can be regulated so as to give exactly the same pressure to each roller used, are preferable to weights, which, from the number wanted, are a considerable load to the floors of the spinning mill, and by all getting into a vibratory motion when at work, very much shake the building. The steel rollers have, at their extremities, small toothed wheels of brass, which are connected with other wheels, and pinions at the side of the frames, so regulated by the number of their teeth, that the second roller goes round faster than the first, and the third faster than the second. The covered rollers are each moved by the steel rollers on which they press, and by this means the slubbing is drawn out twice successively before it passes to the fly. The spinning part for each thread consists of a spindle placed vertically, which sustains the fly and the bobbin. The fly is a steel wire, bent round from the top of the spindle, so that a small ring at its extremity may be about an inch and a quarter from the spindle outwards, and the length of the bobbin below its top, to which it screws on by a small ferule: through the ring the twisting slubbing passes to the bobbin, whose office is merely to roll up the twist as it is spun by the swift revolutions of the spindle; the bobbin is about three inches long, and is perforated longitudinally, so as to permit the spindle to turn round freely within it. That the twist may be rolled up equally on every part of the bobbin, it is necessary that the bobbin should be moved up and down on the spindle with a slow motion; for this purpose all the bobbins in the large frame rest on a horizontal bar of wood, moved up and down by two arms suspended on centres that receive this motion from the revolutions of an heart wheel, or wheel of an oval form. The weight of each of the bobbins pressing it on this bar prevents its being turned round by the spindle, and this resistance causes the fly to wind the twist on it by degrees, gently pulling it round in proportion as the circumference of the bobbin exceeds the length of twist spun in each revolution of the fly. The six spindles, which answer to the six divisions of the steel rollers, are turned round by bands, which pass round an horizontal drum, the axis of which ascends upwards, and gives motion to the fluted rollers by a pinion on its top; this axis receives its motion from other bands, which pass to large drums turned by horizontal shafts, running the whole length of the spinning rooms, which ultimately receive their motion from the water wheel, or other primary moving power.

Several sets of the rollers, with their spindles, are fixed in one wooden frame; the spindles are all outside, and the wooden frames are generally double, to contain two rows of the frames of rollers, by which they take up less space. The spindles are divided, as described, to correspond with the rollers, that when any thread breaks, not more of them may be stopped than this small number. Each set of rollers, and their attendant spindles, are stopped instantly by raising a little socket turning on the upright axis, which elevates a small vertical bolt that passes through the small drum to a projecting arm on the lower part of the axis; above which arm, when this bolt is raised, the communication between the drum and the axis ceases, and the drum remains at rest, while the axis revolves within it uninterrupted.

By similar contrivances the drum which gives motion to all the small drums in one wooden frame, can be stopped at pleasure. Each horizontal shaft, which sets the large drums of a whole room in motion, may also be stopped at pleasure, and this system pervades the whole mill, by which means, when any one part becomes damaged, it may be stopped without interrupting the motion of the rest.

In some mills, instead of the large drums, toothed wheels are placed, which impel round small shafts, that pass beneath the frames, where, by corresponding wheels, they turn small-toothed wheels on every upright axis beneath each small drum; but the motion given by the large drums and bands, is accounted to be more steady and uniform than that thus produced.

The general machinery of the cotton mill, by which the various engines described are set in motion, is as follows: The moving power, whether a fall of water, or a steam engine, is, by intervening wheels, adapted to its nature, made to turn round a vertical shaft, which passes through all the stories or floors of which the mill consists; in each of which it is furnished with a horizontal toothed wheel, which gives motion to a vertical wheel, to which is attached a horizontal shaft going across one end of the floor, which gives motion to two or more other horizontal shafts, according to the breadth of the

building, which run the whole length of the story; these give motion again to small vertical shafts, which sustain the large drums that set the spinning frames in motion. The horizontal shafts have also drums on them, from whence bands proceed, by which the carding engines and slubbing machines are turned. What is said of the general arrangement of the mill work can only be understood in a general sense, for the number and position of the horizontal shafts, set in motion by the vertical shaft, must vary according to the nature of the buildings, and the disposition of the frames in each floor of them. Where it can be done, it is best to have the vertical shaft placed in the middle of the building, with the horizontal shafts proceeding from both sides of it at every floor, for thus the horizontal shafts sustain less of that twisting motion, which is very injurious to them, and to which they would be more liable, if of the whole length of the building.

The spinning frames are attended by children, to piece the threads when they break, and the whole attendance of the various engines is for the most part performed by children also. The numbers employed of persons of this tender age in some large mills amount to some hundreds.

Some of the great cotton mills were worked incessantly night and day, and different sets of children relieved each other in succession in attending them. This system was found to be very injurious to the children. An act of parliament was passed enforcing salutary regulations on these points, which has been warmly seconded by the humane proprietors of some of the most eminent mills; who have their buildings now well ventilated and warmed, (by means contrived by gentlemen best skilled in such matters) have them kept constantly clean and sweet by obvious methods, and have not only the health of the children further preserved by proper attention to their food, clothing, and personal cleanliness; but also have them taught to read and write, and take care that they receive instructions as to their morals and religion, both of which were shamefully neglected in former times. All that remains to be wished now on this head is, that in those situations, where avaricious masters wish to evade the act, or do not choose to pay proper attention to the children in other respects, that humane people may be found, who will interpose, and compel them to do their duty, and either by Sunday schools, or other proper means, effect that the children may receive those instructions, without which they can never be worthy members of society.

After the cotton is spun, it is usually made up into warps fit for the weavers before it leaves the mills; this operation is performed on the following engine:

The Warping Mill. The warping mill consists of a light frame-work, which forms the outline of an octagonal prism, or one of more numerous sides, about six feet diameter, and seven feet high, that is turned round on a vertical axis by a band, that passes from a grooved wheel on the axis to another grooved wheel that is turned by a winch, and is placed under the seat on which the warper sits; the bobbins which sustain the twist are placed on a vertical rack suspended from the ceiling, and the threads from them pass between two small upright rollers, on a piece of wood which slides perpendicularly along an upright bar, fixed at one side of the revolving frame; a small cord passes, from a part of the axis that rises above the frame, over a pulley at the top of the fixed bar, down to the sliding guide, which it slowly draws up, by coiling round the axis as the frame turns round; by which means the yarn is wound spirally about the frame, to the length which the warp is required; to which extent, when the yarn arrives, it is crossed on pins projecting from the frame, and the mill is turned the reverse way; by which the slide descends, and the yarn is laid along the same spiral downwards, along which it before ascended.

When the warp is completed to the number of threads required for the web for which it is intended, it is taken off the mills, and wound up into a ball, the crossings being first properly secured for the use of the weaver: and in this state it is sold to the weaving manufacturer, when the mill owner is not concerned in this branch of business himself.

Of Weaving. A vast variety of fabrics are formed of cotton; every species made of linen or silk has been successfully imitated with it; and the velverets and thick cords made of it, have been found to answer for many purposes in place of woollen cloth. The finest muslins of India do not exceed those which are made in this country; and the richness of colour, and variety of figure, of the chintzes of the East, are now surpassed by those of our printed cottons: from the excellence of these goods, and the low prices at which the extensive use of machinery allows them to be sold, the exportation has become prodigious; and the comforts of

the lower classes at home are considerably encreased, from the cheap rate at which they can procure most articles of clothing of this kind.

There is no mode of weaving peculiar to cotton, so that on this head we must refer to the article WEAVING for information, as every cotton stuff is woven in a way resembling that of some other fabric, unless we may except that called Marseilles; though stuffs may be made of linen or silk, or a mixture of linen and woollen, in a similar manner to that in which this is formed.

The loom for weaving Marseilles is somewhat similar to the diaper loom. A good idea of the manner in which it is prepared may be had, by conceiving two webs woven one under the other in the same loom, which are made to intermingle at all the depressed lines, which form the reticulations on the surface, in imitation of the quilting performed by hand.

When the species of Marseilles, called Marseilles quilting, is made, a third warp, of softer materials than the two others described, lies between them, and merely serves as a sort of stuffing to the hollow squares formed by them.

Another sort of cotton stuff, solely appropriated to quilts, should, in strictness, be set down exclusively to the cotton manufacture; though there is nothing to prevent its being made of other materials. The weft of those quilts is of very coarse and thick yarn, which is drawn out by a small hook into little loops, as it is woven, that are so arranged, as altogether to form a regular pattern; every third or fourth shoot of the shuttle, the weaver has to stop to form those loops from a draft, which causes the weaving of those quilts to take up more time than that of any other stuff, except tapestry; which accounts for the greatness of the price at which they are sold, in proportion to the value of the materials of which they are principally composed.

Before concluding the head of weaving, it will be proper to notice a considerable improvement added to one of the principal implements for this operation, which first originated in the cotton manufacture; which is a very simple apparatus attached to the batton, by which the shuttle is thrown through the warp without requiring to be touched by the hand; as it may be set in motion both ways by the same hand, the weaver saves the time that is lost in shifting hands in the common way of weaving; and from this cause, added to other circumstances, is enabled to weave a considerable quantity more in a day by the use of this contrivance; and, which is in reality still more material to him, by enabling him to sit at his work in an erect posture, prevents that frequent stooping forwards, and consequent pressure on the chest, which was found to be so extremely unwholesome in this business, that a very great proportion of weavers died annually of complaints on the lungs, originating from this circumstance alone.

The Fly Shuttle. The apparatus by which this is effected is known by the appellation of the fly-shuttle, or flying shuttle, (probably from the swiftness of the motion of the shuttle, when it is used). It consists of a little oblong trough, attached to each side of the batton in front, so that the end of each shall lie exactly opposite to the aperture formed in the warp for passing the shuttle, when the treadles are pressed down; a small cubic piece of wood, usually covered with hard leather, slides back and forwards in each trough, and is retained within it by a thick wire, which runs through its upper part, and proceeds from the further end of the trough, which has a button, or knob, on the end next the web, that prevents the little wooden cube from slipping off; from the moveable cube in one trough, a cord proceeds loosely over the web to that in the opposite trough, and a turned handle is attached to the middle of this cord, by which the weaver puts the little cubes in motion; the shuttle is straight-sided, and is sloped off to a point at both ends, which are tipped with iron; very light and well-turned little wheels are let into the substance of the shuttle at each end, and project little more than the eighth of an inch beyond its surface; and on these it runs along the lower rail of the batton, over the lower threads of the warp when it is thrown. When the weaver works with this apparatus, he first presses back one of the sliding cubes to the further end of the trough in which it lies, and lays the shuttle in the trough directly between it and the web, first fastening the end of the yarn contained by the shuttle properly to the web; then pressing down the treadle, he takes up the handle which puts the sliding cubes in motion, and by a gentle jerk of his hand pulls the cube, which is behind the shuttle, towards the web; the quick motion of the sliding cube is directly communicated to the shuttle, and it flies rapidly through the warp into the trough at the other side, pressing back the contrained sliding cube

as it passes to its end; from whence a slight motion of the hand in the opposite direction impels it back again to its first position, after the thread shot in has been beaten up close to the web, and the warp been opened again, ready to receive another course.

The apparatus described is now in general use, in most other manufactures, and is found to be particularly advantageous in weaving broad cloths, carpets, and other goods of great breadth, which formerly required two men to each loom, merely to throw the shuttle.

In places where it is not yet introduced, it evidently would be an object of humanity to induce the weavers to use it, on account of the beneficial effects it has on their health.

Burning. When the webs are taken from the looms, they are covered with an irregular down or knap, from the projection of the short fibres of the cotton wool, which is removed by passing the webs over a red-hot iron plate, that burns it off.

The apparatus for this operation consists of an iron semi-cylinder, set horizontally in brick-work, having a fire-place under it, with an iron door, through which fuel may be introduced; at each side of this is placed a light wooden roller of rail-work, turning freely on an iron axis by a winch; from the same uprights which support these rollers, are suspended light frames at each side, which turn on pivots in their centres, by depressing the further ends of which, the cords next the stove raise up a rail, which runs across near the iron semi-cylinder, and which mostly consists of a slight iron rod.

After the fire placed beneath the iron burner has made it red hot, the web, whose surface is to be burned, is rolled up on one of these cylinders, and the end of it is passed over the lifters and hot iron, to the other cylinder; a man stands at each cylinder, and the instant the one at the empty cylinder begins to turn, the lifters are lowered, so as to let the web come in contact with the red-hot iron; by which means its whole surface is drawn over the iron, with that degree of velocity which is just sufficient to burn off the loose filaments, without injuring its fabric. The very finest muslins undergo this operation, and though they are so thin, that the least deviation from the proper velocity, in passing them over the iron, causes them to be burned through, yet there very seldom happens any accident to them, which shews that this process is more hazardous in appearance than reality.

After burning, the webs are all bleached, to remove the dark colour given them by the fire; and when of a proper whiteness, those which are designed for dyeing or printing are sent to the respective artists in those lines, and the rest are made up for sale as they are.

The operation of printing has arrived to great perfection, and the process of bleaching is well worthy of attention; but for these we must refer to their proper heads.

In concluding the account of the cotton manufacture, it may not be unacceptable to give some short relation of the manner in which it is carried on in India, where it existed, and produced an extensive commerce, for ages before it was thought of in Europe.

The manner of manufacturing cotton in India forms a remarkable contrast to the European method. In Europe, a vast apparatus of machinery is used in every part of the process, while in India the simplest instruments are made to produce fabrics of that exquisite fineness, which it is the boast of our manufacturers to imitate, and which as yet they can scarcely equal. The cotton wool in India is prepared for the spinner without cards, is spun for the weaver without wheels, and is woven in looms without any frame-work, which the weaver can move from one place to another, with as much facility as the web itself.

The operation which our manufacturers perform by carding engines, is executed by the Indian with nothing more than a bow; the percussions of whose string snapped over the cotton wool in repeated vibrations, raises it to a fine downy fleece; in this same way our hatters prepare their furs for felting, an operation which may be seen in most towns.

The fine thread, or yarn, from which the choicest muslins are made, are spun from cotton thus prepared, by the distaff and spindle, a mode which it is evident was practised by the Romans, Greeks, and Egyptians, from their history, their fables, and their sculptures, and than which nothing can be more simple; this yarn is then wove on the following loom, the account of which is abridged from that of an eminent writer on Indian affairs.

Indian Loom. The Indian loom consists merely of two bamboo-rollers, one for the warp, and the other for the web, and a pair of geer; the shuttle performs the double office of shuttle and batton, and

for this purpose is made like a large netting needle, and of a length somewhat exceeding the breadth of the piece.

This apparatus the weaver carries to whatever tree affords a shade most grateful to him, under which he digs a hole large enough to contain his legs, and the lower part of the geer; he then stretches his warp by fastening his bamboo rollers at a due distance from each other on the turf by wooden pins; the balances of the geer he fastens to some convenient branch of the tree over his head; two loops underneath the geer, in which he inserts his great toes, serve instead of treadles; and his long shuttle, which performs also the office of a batton, draws the weft, throws the warp, and afterwards strikes it up close to the web: in such looms as this are made those admirable muslins, whose delicate texture the European could never equal with all his complicated machinery.

MANUFACTURES, may be defined, the arts by which natural productions are brought into the state or form in which they are consumed or used. The principle manufactures are those which fabricate the various articles of clothing; as the woollen-manufacture, the leather-manufacture in part, the cotton-manufacture, the linen-manufacture, and the silk-manufacture; others supply articles of household furniture, as the manufactures of glass, porcelain, earthenware, and of most of the metals in part; the iron-manufacture furnishes implements of agriculture, and weapons of war; and the paper-manufacture supplies a material for communicating ideas and perpetuating knowledge. Manufactures had begun to flourish in different parts of Europe, long before they were attempted in Britain; the few articles of this description which were in request, being obtained in exchange for wool, hides, tin, and such other produce as the country in a very uncultivated state could supply. In 1337, it was enacted, that no more wool should be exported; that no one should wear any but English cloth; that no cloths made beyond seas should be imported; that foreign clothworkers might come into the King's dominions, and should have such franchises as might suffice them. Before this time, the English were little more than shepherds, and wool-sellers. The progress of improvement, since the establishment of manufactures in this country, has in most instances been remarkably great, particularly of late years, in consequence of an increased knowledge of the properties of various materials, vast improvements in all kinds of machinery, and the great capitals invested in most of the different branches. The value of British manufactures exported to all countries, on an average of six years, ending with 1774, was 10,342,019*l.*; the American war suspended for a time an important market for several of our manufactures, in consequence of which the total amount exported had fallen in 1781 to 7,633,332*l.* and on an average of six years, ending with 1783, it was 8,616,660*l.* During the peace which followed, the export trade rapidly revived, and, in the year preceding the war with France, had attained to a magnitude beyond all former example; it was checked a little by the mercantile embarrassments in 1793, but a few years after, the unsettled state of several of the principal European powers threw many additional branches of foreign trade into the hands of our merchants, and carried the export of our manufactures to its present important extent. The real value of British produce and manufactures exported, as far as it can be ascertained, under the ad valorem duties, or computed at the average current prices of the goods, amounts to more than forty millions sterling. The woollen-manufacture, which is the most ancient and important, has increased during the last twenty years, and appears to be still increasing, notwithstanding the high price of the material, and the precarious state of the foreign markets. On an examination of the principal woollen-manufactures, by a committee of the House of Commons, it was estimated the quantity of wool grown in this country at 600,000 packs, of 240 pounds each, which, at 11*l.* per pack, makes the value of the whole 6,600,000*l.* But it was justly observed, that it is difficult to ascertain how much the wool is increased in value by being manufactured; some sorts are increased rather more than double, some nine times, or even more; but if the average is taken at only three times, which will be under the truth, the total value of the wool manufactured in the country will amount to 19,800,000*l.* It must be remarked, that this calculation is founded on a supposition that, in 1791, the number of sheep in the kingdom was 28,800,000, which, as far as any idea can be formed from the proportion of the consumption of the metropolis, to that of the whole island, and the stock requisite for the supply, greatly exceeded the truth at that time; and it is the general opinion, particularly of persons in the wool-trade, that of late the number of

sheep kept has been considerably reduced.

The calculation is likewise made at an unusually high price of wool; for though during the year 1800, the average price was about eleven guineas, the average of the four preceding years was certainly not more than from ten pounds to ten guineas; upon the whole, the estimate, therefore, will be much less objectionable, if formed on 500,000 packs at 10*l.* 10*s.* per pack, which will make the value of the wool 5,250,000*l.*; to this must be added at least 500,000*l.* for the value of Spanish wool imported, and the manufactured value of the whole will be 17,250,000*l.* That the total value of the manufacture cannot exceed this sum will appear highly probable from the exports. The average value of woollen goods exported from Great Britain at the close of the last century was 5,647,928*l.*

Most of the Custom House values of goods exported are greatly below their present value, but not so much so in this article as in some others; they are found, however, to be about thirty-eight per cent. below the actual value, and this addition being made to the average amount, the value of woollen goods exported will appear to be 7,794,140*l.*

The value retained for home consumption may be nearly equal to the value exported, although in quantity the former may greatly exceed the latter, a very considerable proportion of which consists of superfine and second cloths; whereas the consumption of fine woollens in Great Britain has much diminished of late years, from the general use of Manchester manufactures of cotton in clothing, particularly for waistcoats and breeches. The whole value of the manufacture thus appears to be about 15,588,000*l.* and, as a medium between this sum and the amount before stated, it may be taken at 16,400,000*l.* Deducting from this amount at the rate of ten per cent. on the cost of the goods for the profits of the manufacturer, including the interest of his capital, there remains 14,909,090*l.* consisting of the cost of the material, and the wages of labour; the value of all the wool employed, we have seen, is about 5,750,000*l.* and including the cost of some other necessary articles, the materials cannot be valued at less than this sum; the remainder, therefore, or 9,159,090*l.* is the amount of workmanship, or the wages of all the persons employed in the manufacture.

It is scarcely possible to assume with precision an average rate of wages, with respect to any manufacture, as they vary in different parts of the country, and the proportion of the different classes of persons employed is in no instance known with certainty. In the West, where the woollen-manufacture has been for some time past in a very depressed state, few workmen get above 14*s.* per week, and many much less, from not being fully employed; in Yorkshire, good workmen earn from 16*s.* to 18*s.* per week, children 3*s.* older children and women from 5*s.* to 6*s.* and old men from 9*s.* to 12*s.* If, on taking all classes together, 8*s.* per week is not thought too high, it will appear that the whole number of persons employed does not exceed 440,340. The value of the leather-manufacture was some years ago stated at 10,500,000*l.* and from the state of the trade of late, particularly those branches of it which supply military accoutrements, harness, sadlery, carriages, &c. combined with the high price of skins of most kinds, it cannot be supposed less than that sum at present. Deducting 954,545*l.* for the profits of capital employed, and 3,500,000*l.* for the cost of the raw article, there remains 6,045,455*l.* for the wages of persons employed therein, which at 25*l.* per annum for each person, makes the number employed 241,818. The cotton-manufacture was formerly of little importance in this country, in comparison with its present state. The total quantity of cotton-wool imported into England, on an average of five years, ending with 1705, was 1,170,881 pounds, and even so late as the year 1781, it amounted to only 5,101,920 pounds. About that time, however, the British calicoes, which had been introduced a few years before, had arrived at some degree of perfection, and the branch of muslins being added, in which great improvements were soon after made, the whole manufacture experienced such a rapid and great increase, that previously to the commencement of the war with France, the consumption of cotton-wool amounted to upwards of 30,000,000 pounds, per annum. The average value at the time referred to was 35,549,200 pounds, the value of which, when manufactured, cannot be less than 11,000,000*l.* allowing for a considerable quantity exported in a partially manufactured state. The total quantity of British calicoes and muslins printed in England and Wales in the year 1800 was 28,692,790 yards, and in Scotland 4,176,939 yards, the duty on the whole amounting to 479,350*l.* 4*s.* 3½*d.* Upon the supposition that the duty is one-tenth of the value,

the value of this description of goods printed in 1800, will be 4,793,502*l.* The quantity of white calicoes and muslins made in Great Britain is probably much greater than that of the printed; and though they do not incur the expense of printing and duty, yet as a greater proportion of them are fine goods, the value of them is probably rather above 3,500,000*l.*

There are many other branches of manufacture which consume large quantities of cotton, though it is difficult to form an idea of the precise amount; thus the hosiery branch was stated some years ago to employ 1,500,000 pounds, and it has certainly since increased considerably; the same quantity was said to be required for candle-wicks; and it will probably be a very moderate estimate to value all the cotton that is manufactured in any other way than in muslins and calicoes at 2,800,000*l.* The total value of the manufacture will thus appear to be, as before stated, about 11,000,000*l.* Deducting from this sum, 1,000,000*l.* for profits of a capital at ten per cent, and 4,443,650*l.* for cost of the raw material, at 2*s.* 6*d.* per pound, there remains 5,556,350*l.* for wages, which, if divided at the rate of only 16*l.* per annum for each person, on account of the large proportion of women and children employed, makes the whole number 347,271 persons. The silk-manufacture was formerly of greater extent than at present, but has not experienced any very considerable fluctuation for some time; the average quantity of raw and thrown silk imported in three years, preceding the 5th January 1797, was 883,438*l.*; the value of which when manufactured is about 2,700,000*l.* The cost of silk to the manufacturer, if raw and thrown are taken together at only 28*s.* per pound, amounts to 1,260,000*l.* and the profits of the manufacture 245,454*l.* at the rate of ten per cent. on the cost when manufactured.

It may be said, that though this is the usual profit charged by the manufacturer in this and some other branches, in casting up the selling price of his goods, they are frequently sold much under this price; which must be admitted: but, as an advantage is taken on most of the component parts of the price before the ten per cent. is laid on, it is probably not less than this rate on the whole, in this and in most other manufactures. The number of persons employed in the silk-manufactory has been stated at 200,000 and upwards, but there appears no reason to believe that it exceeds 65,000 of all descriptions.

The linen manufacture of Great Britain is chiefly confined to Scotland, though some branches of it are carried on in Manchester and other parts of England. The value estimated at the current prices, of linens exported, on an average of three years preceding 5th of January, 1799, was 1,278,734*l.* therefore, if the quantity retained for home consumption is not greater than the export, the value of the whole must be upwards of 2,500,000*l.*; and it probably will not exceed the truth if the yearly value of the whole of this manufacture in Great Britain, with the thread, and other branches of the flax trade, is stated at 3,000,000*l.* The linens which most of the families in Scotland make for their own use are not stamped, and consequently are not included in these returns, which must therefore be less than the quantity actually manufactured by several millions of yards; and the value stated is certainly much below the actual selling prices. There is no account kept of the linen manufacture in England; and as it is considered as an object of subordinate importance, its annual value is probably under 1,000,000*l.* but even if it is somewhat less than this amount, it will appear that the total value of the manufacture, rated at the current prices, cannot be less than the sum before stated, or 3,000,000*l.* The number of persons employed in it is probably not less than 95,000.

The hemp-manufacture at present exceeds 1,600,000*l.* per annum, but is less in time of peace; the persons employed in it are probably about 35,000.

The paper-manufacture has been greatly advanced of late. A hundred years ago scarcely any paper was made in this country but the coarse wrapping papers; and for a long time most of the superior kinds continued to be imported; the export is, however, at present considerable. The annual value of the manufacture, at the present high prices of the article, cannot be less than 900,000*l.* and the number of persons employed in it 30,000.

The glass-manufacture was much improved in the course of the last century, particularly in the article of plate-glass, and it has greatly increased of late years; it may now amount to 1,500,000*l.* per annum, and the persons employed in it to about 36,000.

The potteries, and manufactures of earthenware and porcelain, advanced

rapidly during the last century, in consequence of the great improvements made in them, and the introduction of many new and beautiful wares, both for our own use and foreign markets. The article of queen's-ware was invented in 1763, by Mr. J. Wedgewood, to whom the public are also indebted for most of those elegant species of earthenware and porcelain which, moulded into a thousand different forms for ornament or use, now constitute the most valuable part of this manufacture. The annual value will probably not be over-rated at 2,000,000*l.* and the number of persons employed at 45,000.

The iron-manufacture is supplied partly by the produce of our own mines, and partly by those of other countries; with respect to the first, it appears that the total produce of pig-iron in Britain is at least 100,000 tons; and reckoning on an average, that 33 cwt. of crude iron produce one ton of bars, and that the manufacture of malleable iron amounts to 35,000 tons per annum, this branch will require 57,750 tons of crude iron; and the value in bars, at 20*l.* a ton, which is considerably under the present price, is 700,000*l.* the remaining 42,250 tons, cast into cannon, cylinders, and machinery, &c. at 14*l.* a ton, are worth 591,500*l.* The supply of foreign bar-iron is chiefly obtained from Russia and Sweden; and the quantity imported on an average of six years, ending with 1805, after deducting what was re-exported, has been 33,628 tons, value 865,182*l.* which, with the sums before mentioned, amount to 2,156,682*l.* This value is greatly increased by subsequent labour: but the proportion of the increase cannot be easily determined, the quantity of labour being so very different in different articles. Some years ago the value of the iron manufacture was estimated at 8,700,000*l.* which sum appears rather too high at present; but including tin and lead, the value of the whole will probably not be taken too high at 10,000,000*l.* and the number of persons employed at 200,000.

The copper and brass manufactures are now established in this country in all their branches. Till about the years 1720 or 1730, most of the copper and brass utensils for culinary and other purposes, used in this country, were imported from Hamburgh and Holland, being procured from the manufactories of Germany; even so late as the years 1745 and 1750, copper tea-kettles, saucepans, and pots of all sizes, were imported here in large quantities; but through the persevering industry, capitals, and enterprising spirit of our miners and manufacturers, these imports have become totally unnecessary, the articles being now all made here, and far better than any other country can produce. The discovery of new copper-mines in Cornwall, Derbyshire, and Wales, about the year 1773, contributed to the extension of the manufacture in this country; and it appears to be still increasing, notwithstanding the very great advance in the price of copper, which must certainly be attended with some disadvantage with respect to foreign markets. The value of wrought copper and brass exported during the year 1799, was 1,222,187*l.* and there is reason to believe, that the whole value of these manufactures at present is at least 3,600,000*l.* and the number of persons employed about 60,000. The steel, plating, and hardware manufactures, including the toy trade, have been carried to a great extent of late years, and may amount in value to 4,000,000*l.* and the persons employed to at least 70,000.

MANULEA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx five-parted; corolla with a five-parted, awl-shaped border, the four upper segments more connected; capsule two-celled, many-seeded. There are eighteen species, mostly natives of the Cape of Good Hope.

MANURE. See AGRICULTURE.

MAP, a plane figure representing the surface of the earth, or some part of it: being a projection of the globular surface of the earth, exhibiting countries, seas, rivers, mountains, cities, &c. in their due positions, or nearly so.

Maps are either universal, or particular. Universal maps are such as exhibit the whole surface of the earth, or the two hemispheres. Particular, or partial maps, are those that exhibit some particular region, or part of the earth. Both kinds are usually called geographical, or land maps, as distinguished from hydrographical, or sea maps, which represent only the seas and sea-coasts, and are properly called charts.

Anaximander, it is said, about 400 years before Christ, first invented geographical tables, or maps. The Pentingerian tables, published by Cornelius Pentinger of Augsburgh, contain an itinerary of the whole Roman Empire; all places, except seas, woods, and deserts, being laid down

according to their measured distances, but without any mention of latitude, longitude, or bearing.

The maps published by Ptolemy of Alexandria, A. D. 144, have meridians and parallels, the better to define and determine the situation of places, and are great improvements on the construction of maps: though Ptolemy himself owns that his maps were copied from some that were made by Marinus, Tirus, &c. with the addition of improvements of his own. But from his time till about the 14th century, during which geography and most sciences were neglected, no new maps were published. Mercator was the first of note among the moderns, and next to him Ortelius, who undertook to make a new set of maps, with the modern divisions of countries and names of places; for want of which, those of Ptolemy were become almost useless. After Mercator, many others published maps, but for the most part they were mere copies of his. Towards the middle of the 17th century, Bleau in Holland, and Sanson in France, published new sets of maps, with many improvements from the travellers of those times, which were afterwards copied, with little variation, by the English, French, and Dutch; the best of these being those of Vischer and De Witt. And later observations have furnished us with still more accurate and copious sets of maps.

Maps are constructed by making a projection of the globe, either on the plane of some particular circle, or by the eye placed in some particular point, according to the rules of perspective.

In maps three things are required: first, to shew the latitude and longitude of places, which is done by drawing a certain number of meridians and parallels of latitude. Secondly, the shape of the countries must be exhibited as accurately as possible, for real accuracy cannot be obtained by any projection, because the map is on a plane surface, whereas the earth is globular. Thirdly, the bearings of places, and their distances from each other, must be shown. The projection of maps is made, as we have observed, according to the rules of perspective. If the eye be supposed to view the earth from an infinite distance, the appearance represented on a plane, is called the orthographic projection. In this case, the parts about the middle are very well represented, but the extreme parts are contracted. Geographers usually employ the stereographic projection, where the eye is supposed to be on the surface of the earth, and looking at the opposite hemisphere. There is likewise the globular projection, in which meridians, equidistant upon the surface of the earth, are represented by equidistant circles in the map. Mercator's projection is that in which both the meridians and parallels of latitude are represented by straight lines. See Chart.

In all maps the upper part is the north, the lower the south, the right hand is eastern, and the left hand western. On the right and left the degrees of latitude are marked; and on the top and bottom the degrees of longitude are marked. When the meridians and parallels of latitude are straight and parallel lines, the latitude of a place is found by stretching a thread over the place, so that it may cut the same degree of latitude on both sides the map, and that degree is the latitude of the place. To find the longitude, stretch a thread over the place, so that it may cut the same degree of longitude on the top and bottom, and that degree is the longitude of the place. When the meridians and parallels of latitude are curve lines, then to find the latitude of a place, a parallel line of latitude must be drawn through it, by the same rules as the other parallels are drawn, and it cuts the sides at the degree of latitude of the place: and to find the longitude of the place, draw a circle of longitude through it, by the same rules as the other circles are drawn, and it cuts the top and bottom at the degree of longitude of the place. We shall now proceed to show some of the most familiar constructions of maps, beginning with a general map, or map of the world, of which there are three methods:

First. A map of the world must represent two hemispheres; and they must both be drawn upon the plane of that circle which divides the two hemispheres. The first way is to project each hemisphere upon the plane of some particular circle, by the rules of orthographic projection, forming two hemispheres, upon one common base or circle. When the plane of projection is that of a meridian, the maps will be the east and west hemispheres, the other meridians will be ellipses, and the parallel circles will be right lines. Upon the plane of the equinoctial, the meridians will be right lines crossing in the centre, which will represent the pole, and the parallels of latitude will be circles having that common centre, and the maps will be the northern

and southern hemispheres. The fault of this way of drawing maps is, that near the outside the circles are too near one another; and, therefore, equal spaces on the earth are represented by very unequal spaces upon the map.

Secondly. Another way is to project the same hemispheres by the rules of stereographic projection; in which way, all the parallels will be represented by circles, and the meridians by circles or right lines. And here the contrary fault happens, *viz.* the circles towards the outsides are too far asunder, and about the middle they are too near together.

Thirdly. To remedy the faults of the two former methods, proceed as follows: 1st. For the eastern and western hemispheres, describe the circle P E N Q for the meridian (Plate Maps, fig. 1.) or plane of projection; through the centre of which draw the equinoctial, E Q, and axis, P N, perpendicular to it, making P and N the north and south pole. Divide the quadrants P E, E N, N Q, and Q P, into 9 equal parts, each representing 10 degrees, beginning at the equinoctial E Q: divide also C P and C N into 9 equal parts, beginning at E Q; and through the corresponding points draw the parallels of latitude. Again, divide C E and C Q into 9 equal parts; and through the points of division, and the two poles P and N, draw circles, or rather ellipses, for the meridians. So shall the map be prepared to receive the several places and countries of the earth. 2dly. For the north or south hemisphere, draw A Q B E, for the equinoctial (fig. 2). dividing it into the four quadrants E A, A Q, Q B, and B E; and each quadrant into 9 equal parts, representing each 10 degrees of longitude; and then, from the points of division, draw lines to the centre, C, for the circles of longitude. Divide any circle of longitude, as the first meridian, E C, into 9 equal parts, and through these points describe circles from the centre, C, for the parallels of latitude; numbering them as in the figure.

In this third method equal spaces on the earth are represented by equal spaces on the map, as near as any projection will bear; for a spherical surface can no way be represented exactly upon a plane. Then the several countries of the world, seas, islands, sea-coasts, towns, &c. are to be entered in the map, according to their latitudes and longitudes.

In filling up the map, all places representing land are filled with such things as the countries contain; but the seas are left white; the shores adjoining to the sea being shaded. Rivers are marked by strong lines, or by double lines, drawn winding in form of the rivers they represent; and small rivers are expressed by small lines. Different countries are best distinguished by different colours, or at least the borders of them. Forests are represented by trees; and mountains shaded to make them appear. Sands are denoted by small points or specks; and rocks under water by a small cross. In any void space, draw the mariner's compass, with the 32 points or winds.

To draw a Map of any particular Country. First. For this purpose its extent must be known, as to latitude and longitude; as suppose Spain, lying between the north latitudes 36 and 44, and extending from 10 to 23 degrees of longitude; so that its extent from north to south is 8 degrees, and from east to west 13 degrees. Draw the line A B for a meridian passing through the middle of the country (fig. 3.), on which set off 8 degrees from B to A, taken from any convenient scale; A being the north, and B the south point. Through A and B draw the perpendiculars C D, E F, for the extreme parallels of latitude. Divide A B into 8 parts, or degrees, through which draw the other parallels of latitude, parallel to the former. For the meridians, divide any degree in A B into 60 equal parts, or geographical miles. Then, since the length of a degree in each parallel decreases towards the pole, from the table, Art. Longitude, showing this decrease, take the number of miles answering to the latitude of B, which is $48\frac{1}{2}$ nearly, and set it from B, 7 times to E, and 6 times to F; so is E F divided into degrees. Again, from the same table take the number of miles of a degree in the latitude A, *viz.* $43\frac{1}{6}$ nearly; which set off, from A, 7 times to C, and 6 times to D. Then from the points of division in the line C D, to the corresponding points in the line E F, draw so many right lines for the meridians. Number the degrees of latitude up both sides of the map, and the degrees of longitude on the top and bottom. Also, in some vacant place, make a scale of miles, or of degrees, if the map represent a large part of the earth, to serve for finding the distances of places upon the map.

Then make the proper divisions and subdivisions of the country: and having the latitudes and longitudes of the principal places, it will be easy to set them down in the map: for any town, &c. must

be placed where the circles of its latitude and longitude intersect. For instance, Gibraltar, whose latitude is 36° 11″, and longitude 12° 27′, will be at G: and Madrid, whose latitude is 40° 10′, and longitude 14° 44′, will be at M. In like manner, the mouth of a river must be set down; but to describe the whole river, the latitude and longitude of every turning must be marked down, and the towns and bridges by which it passes. And so for woods, forests, mountains, lakes, castles, &c. The boundaries will be described by setting down the remarkable places on the sea-coast, and drawing a continued line through them all. And this way is very proper for small countries.

Secondly. Maps of particular places are but portions of the globe, and therefore may be drawn after the same manner as the whole is drawn. That is, such a map may be drawn either by the orthographic or stereographic projection of the sphere, as in the last problem. But in partial maps, an easier way is as follows: having drawn the meridian A B (fig. 3.), and divided it into equal parts as in the last method, through all the points of division draw lines perpendicular to A B, for the parallels of latitude; C D, E F, being the extreme parallel. Then to divide these, set off the degrees in each parallel, diminished after the manner directed for the two extreme parallels C D, E F, in the last method: and through all the corresponding points draw the meridians, which will be curve lines; which were right lines in the last method; because only the extreme parallels were divided by the table. This method is proper for a large tract, as Europe, &c.; in which case the parallels and meridians need only be drawn to every 5 or 10 degrees. This method is much used in drawing maps, as all the parts are nearly of their due magnitude, but a little distorted towards the outside, from the oblique intersections of the meridians and parallels.

Thirdly. Draw P B of a convenient length, for a meridian; divide it into 9 equal parts, and through the points of division describe as many circles for the parallels of latitude, from the centre P, which represents the pole. Suppose AB (fig. 4.) the height of the map, then C D will be the parallel passing through the greatest latitude, and E F will represent the equator. Divide the equator E F into equal parts, of the same size as those in A B, both ways, beginning at B. Divide also all the parallels into the same number of equal parts, but lesser in proportion to the numbers for the several latitudes, as directed in the last method for the rectilineal parallels. Then through all the corresponding divisions draw curve lines, which will represent the meridians, the extreme ones being E C and F D. Lastly, number the degrees of latitude and longitude, and place a scale of equal parts, either of miles or degrees, for measuring distances. This is a very good way of drawing large maps, and is called the globular projection; all the parts of the earth being represented nearly of their due magnitude, excepting that they are a little distorted on the outsides.

Finally. To draw a map of Europe, which extends from 36° to 72° north latitude: draw a base line (fig. 5.) G H, in the middle of which erect a perpendicular, I P, and assume any distance for 10° of latitude. Let the point I be 30°, from which set off six of the assumed distances to P, which will be the north pole. Number the distances 40, 50, 60, &c. and on the centre, P, describe arcs passing through the points of divisions on the line I P, which will be parallels of latitude. Divide the space assumed for 10° of latitude into 60 parts, by some diagonal scale. Look into the table, Art. Longitude, for the number of miles answering to 30°, which is 51.96; take this from the scale, and set it off on the arc 30° from the centre line both ways. Do the same for 40°, 50°, 60°, &c. and through the corresponding divisions on all the arcs draw curve lines; which will represent the meridian. When the degrees of latitude and longitude are marked the thing is done.

When the place is but small that a map is to be made of, as if a country were to be exhibited; the meridians, as to sense, will be parallel to one another, and the whole will differ very little from a plane. Such a map will be made more easily than by the preceding rules. It will here be sufficient to measure the distances of places in miles, and so lay them down in a plane rectangular map.

MAPLE, in botany, is of the genus Acer, which see. Of the several species the most important is the A. saccharinum, or American sugar maple, from which the Americans derive sugar in large quantities, by tapping the trees early in the spring, and boiling the juice. For this purpose large tracts of land in North America are devoted to the culture of this tree, which yields a sugar equal to

the best cane, and which requires no other labour than what women and girls can bestow, in drawing off and boiling the liquor; and when skilfully tapped, the tree will last many years. A tree of an ordinary size yields in a good season from twenty to thirty gallons of sap, from which may be made from five to six pounds of sugar. The tree is tapped with an auger, first on the south side and then on the north, and the sap will flow five or six weeks, according to the temperature of the weather. The sugar is manufactured much in the same manner as the cane sugar of the West Indies. In New York and Pennsylvania many hundred private families have long supplied themselves plentifully with this sugar at little expense. One instance is mentioned of a family, consisting of a father and his two sons, who made nearly eighteen hundred weight in a single season. Dr. Rush, who attended very closely to this subject, supposes that four men, provided with proper conveniences, may make in a common season, of from four to six weeks, 40 cwt. of excellent sugar. The Indians of Canada are said to have practised the making of sugar for centuries; and Europeans, both French and English, have been in the habit of refining it for 140 years. See Sugar.

MAPPIA, in botany, so called from Marcus Mappus, professor of medicine at Strasburg, a genus of the Polyandria Monogynia class and order. Essential character: calyx five-parted; corolla five-petalled; germ superior; berry one-seeded, seeds arilled. There is but one species, *viz.* M. guianensis, a shrub, found on the banks of the river Sinemari in Guiana.

MARALDI (James Philip), in biography, a learned mathematician, astronomer, and natural philosopher, was born in the year 1665, at Perinaldo, in the county of Nice, which had been already honoured by the birth of his maternal uncle, the celebrated Cassini. We are not informed where he received his education; but we are told that after he had for some time successfully cultivated literature, the bent of his genius led him to study the sublimer sciences, and particularly the mathematics. Having made a considerable progress, when he was twenty-two years of age, his uncle sent for him to Paris, where he had been settled a long time, that he might himself superintend his studies, and have the satisfaction of witnessing the efforts of his genius in a country where useful and extraordinary talents, both in natives and foreigners, were at that time much cherished and encouraged. Under such a tutor Maraldi made a wonderful proficiency, and soon answered the most flattering expectations which he had formed of him. To his uncle he implicitly resigned the direction of his studies and his manners, and conceived for him the affection of a son, which met with an equal return. When Cassini found that his nephew's advancement in science, his extraordinary diligence, and his accuracy, had qualified him to become an useful assistant in his astronomical labours, by the direction of the Royal Academy of Sciences, he associated him with himself in making observations on the celestial bodies. A wide field was now opened for the industry and ingenuity of our young astronomer. In making his observations on the planets, he found that Kepler and Bouillaud had incorrectly determined the place of the aphelion of Jupiter. Comparing afterwards his observations with those of the Chaldean astronomers, made in the third century before the Christian era, he found that the nodes of that planet had retrograded more than fourteen degrees, and that owing to their natural motion; and he observed and accounted for other phenomena in the appearance of that planet and its satellites. After an assiduous attention to Mars, he acknowledged that Kepler's theory of that planet was so perfect, that scarcely any thing could be added to it. He corrected, however, some trifling inaccuracies; and he found that the parallax of the planet was less by one second, than had been determined by Cassini in 1672. During almost the whole of the year 1714, his observations were occupied by Saturn; and he shewed how the disappearance of his ring at that time confirmed the theory of Huygens. He also bestowed incredible industry in perfecting the tables of Jupiter's satellites. The results of his numerous observations he communicated to the Academy of Sciences, to whom they afforded the greatest satisfaction, and particularly his discovery, that the eclipses of the satellites were of different durations, even when the distance of their nodes was the same. He was now justly considered as entitled to rank with the most skilful astronomers.

When Maraldi first applied himself to the contemplation of the heavens, he conceived the design of forming a catalogue of the fixed stars, more perfect and comprehensive than that of Bayer, an object of the greatest utility, and of the first importance in astronomy. For they are

considered as so many fixed points, to which the motions of the comets, and of the other planets that are under them, are referred. Hence will appear the importance of an intimate acquaintance with them; the attainment of which is an object of no less difficulty than it is of moment. However, this difficulty did not deter Maraldi, who to the great injury of his health, applied himself to observe them with the most constant attention, at all seasons of the year. By this means he became so intimate with the fixed stars, that on being shown any one of them, however small, he could immediately tell to what constellation it belonged, and its place in that constellation. He has been known to discover those small comets which astronomers often take for the stars of the consellation in which they are seen, for want of knowing precisely of what stars the constellation consists, when others on the same spot, and with eyes directed equally to the same part of the heavens, could not for a long time see any thing of them Whenever Maraldi found it necessary to relax in his astronomical labours, by way of amusement he applied to the study of natural history, making observations on insects, curious petrifactions, &c. To the subject of bees he paid particular attention, not only acquainting himself with what ancient and modern writers have said concerning them, but providing himself with glass hives, that he might observe their labours and economy. On these and other subjects in natural history, he drew up a number of very interesting papers, which were received with great applause by the Academy of Sciences, and are inserted in different volumes of their memoirs. In the year 1699, Maraldi was admitted a member of that body. In 1700, he was employed under Cassini in prolonging the French meridian to the northern extremity of France, and had no small share in completing it. When this business was finished, he paid a visit to Italy, where the astronomers every where gladly availed themselves of his advice and assistance in making their observations; and Eustachio Manfredi has made due acknowledgments of his great obligations to him. Being come to Rome, on the invitation of Pope Clement XI. he assisted at the assemblies of the congregation then sitting in that city, for the purpose of reforming the calendar. Bianchini also availed himself of his advice and aid, in constructing the great meridian line at the baths of Dioclesian. While he continued at Rome, he had an opportunity of observing an eclipse of the fourth satellite of Jupiter, in the upper part of his circle, from which he was led to the conclusion, that its inclination is three minutes less than as fixed by Cassini. In 1703, Maraldi returned to France, with a rich treasure of subjects in natural history, chiefly collected at Verona, which he presented to the Academy of Sciences. In the year 1718, he was employed, with three other academicians, in prolonging the French meridian to the southern extremity of that kingdom. Still, however, the greatest part of his time was occupied within the walls of the observatory of Paris, where he was incessantly employed in observing every thing that was curious and useful in the motions and phenomena of the heavenly bodies, in ingenious applications of the methods laid down by Cassini, in verifying theories with which it is of consequence to be acquainted, in correcting other theories which are susceptible of improvement, and in completing his catalogue. This last mentioned great work he did not live entirely to finish; for just after he had placed a mural quadrant on the terrace of the observatory, in order to observe some stars towards the north and the zenith, he fell sick of a fever, and died in December 1729, in the sixty-fifth year of his age. He is highly commended for seriousness, integrity, sincerity, a generous spirit, the purest morals, and an interesting simplicity of manners. He was not proud of the rank which he held in the scientific world, and was never more gratified than when he could render service to others, by communicating to them freely the discoveries and improvements which he had made, at the expense of inconceivable labour and application. He did not publish his catalogue, or any other of his productions, but communicated an immense number of papers to the Royal Academy of Sciences, which are inserted in their "Memoirs" for almost every year from 1699 to 1729, and not uncommonly several papers in the same year.

MARANTA, in botany, *Indian arrow-root*, a genus of the Monandria Monogynia class and order. Natural order of Scitamineæ. Cannæ, Jussieu. Essential character: calyx three-leaved; corolla trifid; nectary three-parted, the third part bearing the anther on its upper side. There are five species, of which M. arundinacea, Indian arrow-root, has a thick, fleshy, creeping root, full of knots, from which arise many smooth leaves, six or seven inches long, and three broad towards

their base; the stalks about two feet high, the ends of which are terminated by a loose bunch of small white flowers, standing upon peduncles two inches long; the flowers are cut into six narrow segments, indented on their edges; these sit upon the embryo, which afterwards turns to a roundish three-cornered capsule, inclosing one hard rough seed. It is called Indian arrow-root, because it was thought to extract the poison from wounds inflicted by the poisoned arrows of the Indians. The root, washed, pounded fine, and bleached, makes a powder and starch; it is recommended as a proper food for infants, and is gelatinous like salep. It is a native of South America, and is cultivated in the West Indies; it is found in great plenty near La Vera Cruz.

MARATTIA, in botany, so named in honour of Giovanni Francesco Maratti, an Italian botanist, a genus of the Cryptogamia Filices class and order. Natural order of Filices or Ferns. Essential character: capsules oval, gaping longitudinally at top, with several cells on each side. There are three species.

MARBLE is a kind of stone, found in great masses, and dug out of pits and quarries. It is of so hard, compact, and fine a texture as readily to take a beautiful polish, and much used in ornaments of buildings, as columns, statues, altars, tombs, chimney-pieces, tables, and the like. There are infinite numbers of different kinds of marble. Some are of one simple colour, as white or black; others variegated with stains, clouds, waves, and veins: but all opaque, excepting the white, which, cut into thin pieces, becomes transparent. Marble is found in considerable quantities, in most of the mountainous parts of Europe. Derbyshire is that county of England most abounding in this article. Near Kemlyn Bay, in the island of Anglesea, there is a quarry of beautiful marble, called Verde di Corsica, being common to this place, some parts of Italy, and Corsica. Its colours are green, black, white, and dull purple, irregularly disposed. Italy is that part of Europe which produces the most valuable marble, and in which its exportation makes a considerable branch of foreign commerce. The black and the milk-white marble, coming from Carara, a town in the duchy of Massa, are particularly esteemed.

Marbles, *Arundel*, ancient marbles, with a chronicle of the city of Athens inscribed on them, many years before our Saviour's birth; presented to the University of Oxford by Thomas Earl of Arundel, whence the name. See Arundelian.

MARBLING, in general, the painting any thing with veins and clouds, so as to represent those of marble.

Marbling of books or paper is performed thus: dissolve four ounces of gum arabic into two quarts of fair water; then provide several colours mixed with water in pots or shells, and with pencils peculiar to each colour, sprinkle them by way of intermixture upon the gum water, which must be put into a trough, or some broad vessel; then with a stick curl them, or draw them out in streaks, to as much variety as may be done. Having done this, hold your book, or books, close together, and only dip the edges in, on the top of the water and colours, very lightly; which done, take them off, and the plain impression of the colours in mixture will be upon the leaves; doing as well the ends as the front of the book in the like manner, and afterwards glazing the colours.

MARCGRAVIA, in botany, so called from George Marcgraaf, of Leibstadt, a genus of the Polyandria Monogynia class and order. Natural order of Putamineæ. Capparides, Jussieu. Essential character: corolla one-petalled, calyptre-shaped; calyx six-leaved, imbricate; berry many-celled; many-seeded. There is but one species, *viz.* M. umbellata, which is a native of the West Indies, in the cool woody mountains. Brown says, it is frequent in the woods of Jamaica, appearing in such various forms that it has been mistaken for different plants in the different stages of its growth.

MARCHANTIA, in botany, so named in honour of Nicholas Marchant, M. D. a genus of the Cryptogamia Hepaticæ, Jussieu. Essential character: male, calyx salver shaped; anthers numerous, imbedded in its disk: female, calyx peltate, flowering on the under side; capsules opening at top; seeds fixed to elastic fibres. Seven species are enumerated in the "Systema Vegetabilium;" of these five are natives of Britain. M. polymorpha is very common in wet places, on shady walks, and by the sides of wells and springs; in figure it resembles an oak leaf; the peduncles are in the angles of the lobes, from one to three inches high; capsules greenish, dividing into eight segments; on the upper surface are glass-shaped conical cups, on short pedicles, with a wide scalloped margin, inclosing four little bodies, very finely serrated at the edges.

MARE. See Equus.

MARGARITARIA, in botany, a genus of the Dioecia Octandria class and order. Essential character: male, calyx four-toothed; corolla four-petalled: female, calyx and corolla as in the male; styles four or five; berry cartilaginous, four or five grained. There is but one species, *viz.* M. nobilis, found in Surinam.

MARICA, in botany, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: corolla six-parted, with three alternate segments, as small again as the others; stigma petal-form, trifid, with the three divisions simple, acute; capsule three-celled, inferior. There is but one species, *viz.* M. paludosa, a native of the moist meadows of Guiana.

MARILA, in botany, a genus of the Polyandria Monogynia class and order. Essential character: calyx five-leaved; corolla five-petalled; capsule four-celled, many-seeded; stigma simple. There is but one species, *viz.* M. racemosa, a native of the West Indies.

MARINE, a general name for the navy of a kingdom or state; as also the whole economy of naval affairs, or whatever respects the building, rigging, arming, equipping, navigating, and fighting ships. It comprehends likewise the government of naval armaments, and the state of all the persons employed therein, whether civil or military.

Marine *acid.* See Muriatic *acid.*

Marine-*chair*, a machine invented for viewing the satellites of Jupiter at sea, and thereby determining the longitude of their eclipses.

Marine *remains*, a term used to express the shells of sea-fishes, and parts of crustaceous and other sea-animals, found in digging at great depths in the earth, or on the tops of high mountains. Being found in these situations, is an evident and unquestionable proof of the sea having been once there, since it must have covered those places where it has left its productions. It has been the general opinion, that these marine bodies were carried to the places where they are occasionally found by the waters of the universal deluge, described in the Old Testament. There are, however, evident proofs that it cannot have been the cause of all that is attributed to it, and there must have been some other cause of many of these remains having been placed where we now find them.

Marine *surveyor*, is the name of a machine, contrived by Mr. H. de Saumarez, for measuring the way of a ship at sea. The machine is in the form of the letter Y, and is made of iron, or other metal. At each end of the lines which constitute the angle or upper part of the letter, are two pallets, not much unlike the figure of the log; one of which falls in the same proportion as the other rises. The falling or pendant pallet meeting a resistance from the water, as the ship moves, has by that means a circular motion under water, which is faster or slower according as the vessel moves. This motion is communicated to a dial within the ship, by means of a rope fastened to the tail of the Y, and carried to the dial. The motion being thus communicated to the dial, which has a bell in it, it strikes exactly the number of paces, miles, &c. which the ship has run. Thus the ship's distance is ascertained, and the forces of tides and currents may also be discovered by this instrument. See Phil. Trans.

MARINER'S *compass*, is an instrument used at sea by mariners to direct and ascertain the course of their ships. It consists of a circular brass box, which contains a paper card with the 32 points of the compass or winds, fixed on a magnetic needle that always turns to the north, excepting a small deviation, which is variable at different places, and at the same place at different times. The needle, with the card, turns on an upright pin fixed in the centre of the box. To the middle of the needle is fixed a brass conical socket or cap, by which the card hanging on the pin turns freely round the centre. The top of the box is covered with a glass, to prevent the wind from disturbing the motion of the card. The whole is inclosed in another box of wood, where it is suspended by brass hoops or gimbals, to keep the card in a horizontal position during the motions of the ship. The whole is to be so placed in the ship, that the middle section of the box, parallel to its sides, may be parallel to the middle section of the ship along its keel. See Plate Miscel. fig. 9.

The mariner's compass was long very rude and imperfect, but at length received great improvement from the invention and experiments of Dr. Knight, who discovered the useful practice of making artificial magnets; and the farther emendations of Mr. Smeaton and Mr. M'Culloch, by which the needles are larger and stronger than formerly, and instead of swinging in gimbals, the compass is supported in its very centre upon a prop, and the centres of motion, gravity, and mag-

netism, are brought almost all to the same point. After the discovery of that most useful property of the magnet, or loadstone, *viz.* its giving a polarity to hardened iron or steel, the compass was many years in use before it was known in anywise to deviate from the poles of the world. About the middle of the sixteenth century, so confident were some persons that the needle invariably pointed due north, that they treated with contempt the notion of the variation, which about that time began to be suspected. However, careful observations soon discovered, that in England and its neighbourhood, the needle pointed to the eastward of the true north line; and the quantity of this deviation being known, mariners became as well satisfied as if the compass had none; because the true course could be obtained by making allowance for the true variation.

From succeeding observations it was afterwards found, that the deviation of the needle from the north was not a constant quantity, but that it gradually diminished, and at last, namely about the year 1657, it was found that the needle pointed due north at London, and has ever since been going to the westward.

The azimuth compass differs from the common sea compass in this, that the circumference of the card or box is divided into degrees; and there is fitted to the box an index with two sights, which are upright pieces of brass, placed diametrically opposite to each other, having a slit down the middle of them, through which the sun or star is to be viewed at the time of observation. See Azimuth.

The figure of the compass card, with the names of the 32 points or winds, are given, Plate Miscel. fig. 10. As there are 32 whole points quite around the circle, which contains 360 degrees, therefore each point of the compass contains the thirty-second part of 360, that is, $11\frac{1}{4}$ degrees, or $11° 15'$; consequently the half point is $5° 37' 30''$, and the quarter point $2° 48' 45''$.

The points of the compass are otherwise called rhumbs; and the numbers of degrees, minutes, and seconds, made by every quarter point with the meridian, are exhibited in the following table.

A TABLE

Of Rhumbs, shewing the Degrees, Minutes, and Seconds, that every Point and Quarter-point of the Compass makes with the Meridian.

North.		Pts.	qr.	°	′	″	Pts.	qr.	South.	
		0	1	2	48	45	0	1		
		0	2	5	37	30	0	2		
		0	3	8	26	15	0	3		
N b E	N b W	1	0	11	15	0	1	0	S b E	S b W
		1	1	14	3	45	1	1		
		1	2	16	52	30	1	2		
		1	3	19	41	15	1	3		
N N E	N N W	2	0	22	30	0	2	0	S S E	S S W
		2	1	25	18	45	2	1		
		2	2	28	7	30	2	2		
		2	3	30	56	15	2	3		
N E b N	N W b N	3	0	33	45	0	3	0	S E b S	S W b S
		3	1	36	33	45	3	1		
		3	2	39	22	30	3	2		
		3	3	42	11	15	3	3		
N E	N W	4	0	45	0	0	4	0	S E	S W
		4	1	47	48	45	4	1		
		4	2	50	37	30	4	2		
		4	3	53	26	15	4	3		
N E b E	N W b W	5	0	56	15	0	5	0	S E b E	S W b W
		5	1	59	3	45	5	1		
		5	2	61	52	30	5	2		
		5	3	64	41	15	5	3		
N N E	W N W	6	0	67	30	0	6	0	E S E	W S W
		6	1	70	18	45	6	1		
		6	2	73	7	30	6	2		
		6	3	75	56	15	6	3		
E b N	W b N	7	0	78	45	0	7	0	E b S	W b S
		7	1	81	33	45	7	1		
		7	2	84	22	30	7	2		
		7	3	87	11	15	7	3		
East	West	8	0	90	0	0	8	0	East	West

MARINES, a body of soldiers raised for the sea service, and trained to fight either in a naval engagement or in an action at shore. The direction of this body is vested in the Lords Commissioners of the Admiralty. It is stationed in three divisions, one at Chatham, one at Portsmouth, and another at Plymouth.

MARITIME, something relating to, or bounded by the sea: thus, a maritime province, or country, is one bounded by the sea; and a maritime kingdom or state is one that makes a considerable figure, or is very powerful at sea. Hence, by maritime powers, among the European states, are understood Great Britain and Holland.

MARK, in commerce, a certain note which a merchant puts upon his goods, or upon the cask, hogshead, &c. that contains them, in order to distinguish them from others, such as a grape, a crow's foot, a diamond, a cross, an asterisk, &c. Some use one or other of these marks by themselves; others join them with the initial letters of their own name, and others use the letters only.

Mark, or Marc, also denotes a weight used in several states of Europe, and for several commodities, especially gold and silver. In France the mark is divided into eight ounces, or sixty-four drachms, or one hundred and ninety-two derniers or penny-weights, or one hundred and sixty esterlines, or three hundred mailles,

or six hundred and forty felins, or four thousand six hundred and eight grains. In Holland the mark-weight is also called troy-weight, and is equal to that of France. When gold and silver are sold by the mark, it is divided into twenty-four caracts. See CARACT.

MARK is also used among us for a money of account, and in some other countries for a coin. The English mark is two thirds of a pound sterling, or thirteen shillings and four-pence, and the Scotch mark is of equal value in Scotch money of account. The mark-lubs, or Lubeck-mark, used at Hamburgh, is also a money of account, equal to one-third of the rix-dollar, or to the French livre: each mark is divided into sixteen sols-lubs. Mark-lubs is also a Danish coin equal to sixteen sols-lubs. Mark is also a copper and silver coin in Sweden.

MARKET, the establishment of public marts or places of buying and selling, with the tolls belonging to it, is enumerated as one of the King's prerogatives, and markets can only be set up by virtue of the King's grant, or by immemorial usage.

All sales and contracts, of any thing saleable in markets overt, will not only be good as between the parties, but binding also upon all persons having any property therein.

In London, every shop in which goods are exposed publicly to sale, is market overt for such things only as the owner professes to trade in; though if the sale be in a warehouse, and not publicly in the shop, the property is not altered; but if goods are stolen from one, and sold out of the market overt, the property is not altered, and the owner may take them wherever he finds them. If a man buy his own goods in a market, the contract shall not bind him, unless the property had been previously altered by a former sale.

MARLE, in mineralogy, is divided into two sub-species, *viz.* the earthy marle, and the indurated marle: the former is of a yellowish grey colour, principally employed for improving bad land. It is found in Thuringia. The latter is grey; it occurs massive; the lustre is dull; it is opaque, soft, so as to yield to the nail, easily frangible, and not very heavy; it melts before the blow-pipe into a blackish kind of glass; it effervesces with acids; it occurs in beds in the floetz lime-stone, and independent coal formations; in the first it alternates with beds of lime-stone, and sometimes occurs in nests of it. It is found in the coal works near Dresden, and is employed in improving bad land; as also mortar, and where lime-stone is not easily had, in the smelting of ores of iron. In the business of agriculture, marle is distinguished into the common, which includes the earthy marle, and some varieties of potters' clay; stone-marle, which is the earthy indurated; slate marle, which is the slaty indurated; shell-marle, which is either the earthy or indurated, abounding with shells. Mr. Jameson says, it passes into lime-stone and indurated clay, and according as alumina or silica preponderates, it receives the name of clay or lime marle.

MARQUE, or *Letters of Marque*, in military affairs, are letters of reprisal, granting the subjects of one prince or state liberty to make reprisals on those of another. Letters of marque, among us, are extraordinary commissions granted by authority, for reparation to merchants taken and despoiled by strangers at sea; and reprisals is only the retaking, or taking of one thing for another. In the prosecution of these letters there must be, 1. The oath of the person injured, or other sufficient proof, touching the injury sustained. 2. A proof of due prosecution for satisfaction in a legal way. 3. The deferring or denial of justice. 4. A complaint to his own prince or state. 5. A requisition of justice made to the supreme head of the state. After all which, letters of reprisal, under certain restrictions, are issued; but if the supreme power think these letters of reprisal may affect the peace of the state, they are put off till a more convenient time.

MARQUETRY, or INLAID *work*, is a curious work composed of several fine hard pieces of wood, of various colours, fastened in thin slices on a ground, and sometimes enriched with other matters, as silver, brass, tortoise-shell, and ivory; with these assistances, the art is now capable of imitating any thing; whence it is by some called the art of painting in wood.

The ground on which the pieces are to be arranged and glued, is usually of well dried oak or deal, and is composed of several pieces glued together, to prevent its warping. The wood to be used in marquetry is reduced into leaves, of the thickness of a line, or the twelfth part of an inch, and is either of its natural colour, or stained, or made black, to form the shades by other methods: this some perform by putting it in sand heated very hot over the fire: others by steeping it in lime water and sublimate; and others in oil of sulphur. The wood being of the proper colours, the contours of the pieces

are formed according to the parts of the design they are to represent: this is the most difficult part of marquetry, and that which requires the most patience and attention.

The leaves to be formed, of which there are frequently three, four, or more joined together, are, after they have been glued on the outermost part of the design, whose profile they are to follow, put within the chaps of the vice; then the workman pressing the treddle, and thus holding fast the piece, with his saw runs over all the outlines of his design. By thus joining or forming three or four pieces together, not only time is saved, but also the matter is the better enabled to sustain the effort of the saw, which, how fine soever it may be, and how slightly soever it may be conducted by the workman, except this precaution were taken, would be apt to raise splinters, and ruin the beauty of the work. All the pieces having been thus formed by the saw, and marked, in order to their being known again, each is veneered, or fastened in its place, on the common ground, with the best English glue; and this being done, the whole is set in a press to dry, planed over, and polished with the skin of the sea-dog, wax, and shave-grass, as in simple veneering, and the fine branches and more delicate parts of the figures are touched up and finished with a graver.

MARQUIS, a title of honour, next in dignity to that of duke, first given to those who commanded the marches, that is, the borders and frontiers of countries. Marquisses were not known in England, till King Richard II. in the year 1337, created his great favourite, Robert Vere, the earl of Oxford, Marquis of Dublin; since which time there have been many creations of this sort, though at present there are twelve English, two Scotch, and nine Irish marquisses. The manner of creating a marquis differs in nothing from that of a duke, except the difference of the titles, and the marquis's being conducted by a marquis and an earl, while a duke is led by a duke and a marquis: he is also girt with a sword, has a gold verge put into his hand, and his robe or mantle is the same as those of a duke, with only this difference, that a duke's mantle has four guards of ermine, and a marquis's only three and a half. The title given him, in the stile of the heralds, is most noble and potent prince. His cap is the same as a duke's, and the difference between their coronets consists in the duke's being adorned with only flowers or leaves, while the marquis's has flowers and pyramids with pearls on them intermixed, to show that he is a degree between a duke and an earl.

MARRIAGE, is the lawful conjunction of man and wife; it was also anciently used to denote the interest of bestowing a ward or a widow in marriage.

Taking marriage in the light of a civil contract, the law treats it as it does all other contracts: allowing it to be good and valid in all cases where the parties, at the time of making it, were in the first place willing to contract; secondly, able to contract; and, lastly, actually did contract, in the proper forms and solemnities required by law.

By several statutes, a penalty of 100*l.* is inflicted for marrying any persons without banns or licence; but by 26 George II. c. 33, if any person shall solemnize matrimony without banns or licence, obtained from some persons having authority to grant the same, or in any other place than a church or chapel where banns have been usually published, unless by special licence from the Archbishop of Canterbury, he shall be guilty of felony, and transported for fourteen years, and the marriage shall be void. Marriages according to the laws of any other country are valid in England, if duly solemnized in another country, as marriages in Scotland are; but by 26 George II. c. 33, s. 11, marriages by licence, where the parties are not twenty-one, must not be without consent of the father or guardian of the party. If the guardian or mother is beyond sea, or insane, the Chancellor will proceed, upon relation, in their stead. Questions have lately arisen, whether this act applies to illegitimate children, and the civilians have held that it does. Marriages cannot be solemnized between persons within the Levitical degrees; but, if solemnized, they are not void till after sentence of the proper court. Promises of marriage, and pre-contracts, do not prevent the parties from lawfully marrying other persons; but an action lies for a breach of the contract. Marriage brokage bonds are void in equity, and all contracts in restraint of marriage generally are void; but contracts and legacies, upon condition not to marry any particular person, or without proper consent, are allowed, though if there is not a devise over, the legacy is vested nevertheless. To marry a woman an heiress forcibly, is a capital felony, by 3 Henry VII. c. 2, and 39 Elizabeth, c. 9.

A wife cannot leave her husband. If she elope from him, she loses her dower,

unless she returns and is reconciled. An action of trespass lies for taking away a wife, with the goods of her husband, and also for criminal conversation with the wife of any one.

If a man ill-use and turn his wife away, she has credit for necessaries wherever she goes, and he is obliged to pay her debts; but it is otherwise, if she elopes or commits adultery. A married woman cannot be sued for her own debts, although she has a separate maintenance.

Divorces are of two kinds, absolute, and from bed and board. The former can only be by act of Parliament, unless it is for some original defect in the marriage; the latter is allowed on account of ill-treatment, &c. and then the wife has alimony or maintenance allowed her.

Marriage, in political economy. The reader may find many curious calculations and remarks relating to this subject in Dr. Price's "Observations on Reversionary Payments." From a variety of facts, it appears, that marriages, one with another, do each produce about four births, both in England and other parts of Europe. Dr. Price observes, that the births at Paris are above four times the weddings; and therefore it may seem, that in the most healthy country situations, every wedding produces above four children; and though this be the case in Paris, for reasons which he has given, he has observed nothing like it in any other great town. He adds, that from comparing the births and weddings in countries and towns where registers of them have been kept, it appears, that in the former, marriages one with another seldom produce less than four children each; generally between four and five, and sometimes above five; but in towns seldom above four, generally between three and four, and sometimes under three. It is necessary to be observed here, that though the proportion of annual births to weddings has been considered as giving the true number of children derived from each marriage, taking all marriages one with another: yet this is only true, when, for many years, the births and burials have kept nearly equal. Where there is an excess of the births, occasioning an increase, the proportion of annual births to weddings must be less than the proportion of children derived from each marriage; and the contrary must take place, where there is a decrease: and by Mr. King's computation, about one in a hundred and four persons marry; the number of people in England being estimated at five millions and a half, whereof about forty-one thousand annually marry. In the district of Vaud, in Switzerland, the married are very nearly a third part of the inhabitants. Major Graunt and Mr. King disagree in the proportions between males and females, the latter making ten males to thirteen females in London; in other cities and towns, and in the villages and hamlets, one hundred males to ninety-nine females; but Major Graunt, both from the London and country bills, computes that there are in England fourteen males to thirteen females; whence he justly infers, that the Christian religion, prohibiting polygamy, is more agreeable to the law of nature than Mahometanism, and others that allow it. This proportion of males to females Mr. Derham thinks pretty just, being agreeable to what he had observed himself. In the hundred years, for instance, of his own parish register of Upminster, though the burials of males and females were nearly equal, being 633 males, and 623 females, in all that time; yet there were baptized 709 males, and but 675 females, which is thirteen females to 13.7 males. From a register kept at Northampton for 28 years, from 1741 to 1770, it appears, that the proportion of males to females, that were born in that period, is 2,361 to 2,288, or nearly 13.4 to 13.

However, though more males are born than females, Dr. Price has sufficiently shown, that there is a considerable difference between the probabilities of life among males and females in favour of the latter; so that males are more short-lived than females; and as the greater mortality of males takes place among children, as well as among males at all ages, the fact cannot be accounted for merely by their being more subject to untimely deaths by various accidents, and by their being addicted to the excesses and irregularities which shorten life. M. Kerseboom informs us, that during the course of 125 years in Holland, females have, in all accidents of age, lived about three or four years longer than the same number of males. In several towns of Germany, &c. it appears, that of 7,270 married persons who had died, the proportion of married men who died, to the married women, was three to two; and in Breslaw, for eight years, as five to three. In all Pomerania, during nine years, from 1748 to 1756, this proportion was nearly 15 to 11. Among the ministers and professors in Scotland, 20 married men die to 12 married women, at a medium of 27 years, or in the proportion of five to three; so that there is the chance of three to two,

and in some circumstances even a greater chance, that the woman shall be the survivor of a marriage, and not the man; and this difference cannot be accounted for merely by the difference of age between husbands and their wives, without admitting the greater mortality of males. In the district of Vaud, in Switzerland, it appears, that half the females do not die till the age of 46 and upwards, though half the males die under 36. It is likewise an indisputable fact, that in the beginning of life, the rate of mortality among males is much greater than among females. From a table formed by Dr. Price, from a register kept for 20 years at Gainsborough, it appears, that of those who lived to 80, the major part, in the proportion of 49 to 32, are females. M. Deparcieux, at Paris, and M. Wargentin, in Sweden, have further observed, that not only women live longer than men, but that married women live longer than single women. From some registers examined by M. Muret, in Switzerland, it appears, that of equal numbers of single and married women, between 15 and 25, more of the former died than of the latter, in the proportion of two to one. With respect to the difference between the mortality of males and females, it is found to be much less in country parishes and villages than in towns; and hence it is inferred, that human life in males is more brittle than in females, only in consequence of adventitious causes, or of some particular debility that takes place in polished and luxurious societies, and especially in great towns. From the inequality above stated, between the males and females that are born, it is reasonable to infer, that one man ought to have but one wife; and yet that every woman, without polygamy, may have a husband; this surplus of males above females being spent in the supplies of war, the seas, &c. from which the women are exempt. Perhaps, says Dr. Price, it might have been observed with more reason, that this provision had in view that particular weakness or delicacy in the constitution of males, which makes them more subject to mortality; and which consequently renders it necessary that more of them should be produced, in order to preserve in the world a due proportion between the two sexes. That this is a work of Providence, is well made out by the very laws of chance, by Dr. Arbuthnot, who supposes Thomas to lay against John, that for 82 years running, more males shall be born than females; and giving all allowances in the computation to Thomas's side, he makes the odds against Thomas, that it does not so happen, to be near five millions of millions of millions of millions to one; but for ages of ages, according to the world's age, to be near an infinite number to one. According to M. Kerseboom's observations, there are about 325 children born from 100 marriages. M. Kerseboom, from his observations, estimates the duration of marriages, one with another, as in the following table. Those whose ages, taken together, make

40, live together between	24 and	25 years.
50	22 . .	23
60	23 . .	21
70	19 . .	20
80	17 . .	18
90	14 . .	15
100	12 . .	13

"Phil. Trans." No. 468.

Dr. Price has shown, that on De Moivre's hypothesis, or that the probabilities of life decrease uniformly, the duration of survivorship is equal to the duration of marriage, when the ages are equal; or, in other words, that the expectation of two joint lives, the ages being equal, is the same with the expectation of survivorship; and, consequently, the number of survivors, or (which is the same, supposing no second marriages) of widows and widowers, alive together, which will arise from any given set of such marriages constantly kept up, will be equal to the whole number of marriages, or half of them (the number of widows in particular) equal to half the number of marriages. Thus, the expectation of two joint lives, both 40, is the third of 46 years, or their complement, *i. e.* 15 years and 4 months; and this is also the expectation of the survivor. That is, supposing a set of marriages between persons all 40, they will, one with another, last just this time, and the survivors will last the same time. In adding together the years which any great number of such marriages, and their survivorships, have lasted, the sums would be found to be equal. It is observed further, that if the number expressing the expectation of single or joint lives, multiplied by the number of single or joint lives whose expectation it is, be added annually to a society or town, the sum gives the whole number living together, to which such an annual addition would in time grow: thus, since 19, or the third of 57, is the expectation of two joint lives, whose common age is 29, or common complement 57, 20 marriages every year between persons of this age would, in 57 years, grow to 20 times 19,

or 380 marriages always existing together. The number of survivors also arising from these marriages, and always living together, would, in twice 57 years, increase to the same number. Moreover, the particular proportion that becomes extinct every year, out of the whole number constantly existing together of single or joint lives, must, wherever this number undergoes no variation, be exactly the same with the expectation of those lives at the time when their existence commenced. Thus, if it were found, that a nineteenth part of all the marriages among any body of men, whose numbers do not vary, are dissolved every year by the deaths of either the husband or wife, it would appear, that 19 was, at the time they were contracted, the expectation of these marriages.

Dr. Price observes, that the annual average of weddings among the ministers and professors in Scotland, for the last twenty-seven years, has been 31; and the average of married persons, for seventeen years, ending in 1767, had been 667. This number, divided by 31, gives 21½, the expectation of marriage among them; which, he says, is above two years and a half more than the expectation of marriage would be, by Dr. Halley's table, on the supposition that all first, second, and third marriages, may be justly considered as commencing, one with another, so early as the age of 30; and he has proved, that the expectation of two equal joint lives, is to the expectation of a single life of the same age, as two to three: consequently, the expectation of a single life at 30, among the ministers in Scotland, cannot be less than 32.25. If we suppose the mean ages of all who marry annually to be 33 and 25, the expectation of every marriage would be nineteen years; or, one with another, they would be all extinct in nineteen years: the marriages which continue beyond this term, though fewer in number, enjoying among them just as much more duration as those that fall short of it enjoy less. But it appears from the observations and tables of M. Muret, that, in the district of Vaud (dividing half the number of married persons, *viz.* 38,328, by the annual medium of weddings, *viz.* 808) the expectation of marriage is only 23½ years: so much higher are the probabilities of life in the country than in towns, or than they ought to be, according to De Moivre's hypothesis. See PRICE'S ANNUITIES.

MARROW, in anatomy, a soft oleaginous substance, contained in the cavity of the bones.

MARRUBIUM, in botany, *horehound*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx salver-shaped, rigid, ten-streaked; corolla upper lip bifid, linear, straight. There are eleven species. These plants are chiefly preserved in botanic gardens for the sake of variety.

MARS, in astronomy, the planet that revolves next beyond the earth in our system, is of a red fiery colour, and always gives a much duller light than Venus, though sometimes he equals her in size. He is not subject to the same limitation in his motions as Mercury or Venus, but appears sometimes very near the sun, and at others at a great distance from him; sometimes rising when the sun sets, or setting when he rises. Of this planet it is remarkable, that when he approaches any of the fixed stars, which all the planets frequently do, these stars change their colour, grow dim, and often become totally invisible, though at some little distance from the body of the planet; but Dr. Herschel thinks this has been exaggerated by former astronomers. Mars appears to move from west to east round the earth. The mean duration of his sidereal revolution is 686.979579 days. His motion is very unequal. When we first perceive this planet in the morning, when he begins to separate from the sun, his motion is direct, and the most rapid possible. This rapidity diminishes gradually, and the motion ceases altogether, when the planet is about 137° distant from the sun; then his motion becomes retrogade, and increases in rapidity till he comes into opposition with the sun. It then gradually diminishes again, and becomes nothing, when Mars approaches within 137° of the sun. Then the motion becomes direct, after having been retrograde for seventy-three days, during which interval the planet described an arc of about 16°. Continuing to approach the sun, the planet at last is lost in the evening rays of that luminary. All these different phenomena are renewed after every opposition of Mars, but there are considerable differences both in the extent and duration of his retrogradations.

Mars does not move in the plane of the ecliptic, but deviates from it several degrees. His apparent diameter varies exceedingly. His mean apparent diameter

is 27″, and it increases so much, that when the planet is in opposition, the apparent diameter is 81″. Then the parallax of Mars becomes sensible, and about double that of the sun. The disk of Mars changes its form relatively to its position with regard to the sun, and becomes oval. Its phases show that it derives its light from that luminary. The spots observed on its surface have informed astronomers, that it moves round its axis from West to East in 1.02733 days, and its axis is inclined to the ecliptic at an angle of about 59.70.

They were first observed in 1666 by Cassini at Bologna, with a telescope about 16½ feet long; and continuing to observe them for a month, he found they came into the same situation in twenty-four hours and forty minutes. The planet was observed by some astronomers at Rome, with longer telescopes, but they assigned to it a rotation in thirteen hours only. This, however, was afterwards shewn by M. Cassini to have been a mistake, and to have arisen from their not distinguishing the opposite sides of the planet, which, it seems, have spots pretty much alike. He made further observations on the spots of this planet in 1670, from whence he drew an additional confirmation of the time the planet took to revolve. The spots were again observed in subsequent oppositions, particularly for several days in 1704, by Maraldi, who took notice that they were not always well defined, and that they not only changed their shape frequently in the space between two oppositions, but even in the space of a month. Some of them, however, continued of the same form long enough to ascertain the time of the planet's revolution. Among these there appeared this year an oblong spot, resembling one of the belts of Jupiter when broken. It did not reach quite round the body of the planet, but had, not far from the middle of it, a small protuberance towards the North, so well defined, that he was thereby enabled to settle the period of its revolution at twenty-four hours thirty-nine minutes, only one minute less than what Cassini had determined it to be.

Besides these dark spots, former astronomers took notice that a segment of his globe about the South pole exceeded the rest of his disk so much in brightness, that it appeared beyond them as if it were the segment of a larger globe. Maraldi informs us, that this bright spot had been taken notice of for sixty years, and was more permanent than the other spots on the planet. One part of it is brighter than the rest, and the least bright part is subject to great changes, and has sometimes disappeared.

A similar brightness about the North pole of Mars was also sometimes observed; and these observations are now confirmed by Dr. Herschel, who has viewed the planet with much better instruments, and much higher magnifying powers, than any other astronomer ever was in possession of. His observations were made with a view to determine the figure of the planet, the position of his axis, &c. See Philosophical Transactions, vol. lxxiv.

"The analogy," says Dr. Herschel, "between Mars and the earth, is, perhaps, by far the greatest in the whole solar system. Their diurnal motion is nearly the same; the obliquity of their respective ecliptics not very different. Of all the superior planets, the distance of Mars from the sun is by far the nearest alike to that of the earth; nor will the length of the Martial year appear very different from what we enjoy, when compared to the surprising duration of the years of Jupiter, Saturn, and the Herschel. If then we find that the globe we inhabit has its polar region frozen and covered with mountains of ice and snow, that only partly melt when alternately exposed to the sun, I may well be permitted to surmise, that the same causes may probably have the same effect on the globe of Mars; that the bright polar spots are owing to the vivid reflection of light from frozen regions, and that the reduction of those spots is to be ascribed to their being exposed to the sun. In the year 1781, the South polar spot was extremely large, which we might well expect, as that pole had but lately been involved in a whole twelvemonth's darkness and absence of the sun; but in 1783, I found it considerably smaller than before, and it decreased continually from the 20th of May till about the middle of September, when it seemed to be at a stand. During this last period the South pole had already been above eight months enjoying the benefit of summer, and still continued to receive the sun-beams, though, towards the latter end, in such an oblique direction, as to be but little benefited by them. On the other hand, in the year 1781, the North polar spot, which had been its twelvemonth in the sun-shine, and was but lately returning into darkness, appeared small, though undoubtedly in-

creasing in size. Its not being visible in the year 1783, is no objection to these phenomena, being owing to the position of the axis, by which it was removed out of sight. It has been commonly related by astronomers, that the atmosphere of this planet is possessed of such strong refractive powers, as to render the small fixed stars near which it passes invisible. Dr. Smith relates an observation of Cassini, where a star in the water of Aquarius, at the distance of six minutes from the disk of Mars, became so faint before its occultation, that it could not be seen by the naked eye, nor with a three feet telescope. This would indicate an atmosphere of a very extraordinary size and density; but the following observations of Dr. Herschel seem to show that it is of much smaller dimensions. "1783, Oct. 26th. There are two small stars preceding Mars, of different sizes; with 460 they appear both dusky red, and are pretty unequal; with 218 they appear considerably unequal. The distance from Mars of the nearest, which is also the largest, with 227 measured 3′ 26″ 20‴. Some time after, the same evening, the distance was 3′ 8″ 55‴, Mars being retrograde. Both of them were seen very distinctly. They were viewed with a new twenty feet reflector, and appeared very bright. October 27th, the small star is not quite so bright, in proportion to the large one, as it was last night, being a good deal nearer to Mars, which is now on the side of the small star; but when the planet was drawn aside, or out of view, it appeared as plainly as usual. The distance of the small star was 2′ 5″ 25‴. The largest of the two stars (adds he,) on which the above observations were made, cannot exceed the twelfth, and the smallest the thirteenth or fourteenth magnitude; and I have no reason to suppose that they were any otherwise affected by the approach of Mars, than what the brightness of its superior light may account for. From other phenomena it appears, however, that this planet is not without a considerable atmosphere; for besides the permanent spots on its surface, I have often noticed occasional changes of partial bright belts, and also once a darkish one in a pretty high latitude; and these alterations we can hardly ascribe to any other cause than the variable disposition of clouds and vapours floating in the atmosphere of the planet."

MARSHALLIA, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Generic character: calyx common, many-leaved, spreading; leaflets linear lanceolate, blunt, concave, almost equal, permanent; corolla compound, uniform, longer than the calyx; stamen filaments five, capillary; pistil germ ovate; pericarpium none; seeds solitary; receptacle chaffy.

MARSHALLING *a coat*, in heraldry, is the disposal of several coats of arms belonging to distinct families, in one and the same escutcheon or shield, together with their ornaments, parts, and appurtenances.

MARSHALSEA *court*, is a court of record, originally instituted to hear and determine causes between the servants of the king's household, and others, within the verge; and has jurisdiction of things within the verge of the court, and of pleas of trespass, where either party is of the king's family, and of all other actions personal, wherein both parties are the king's servants; but the court has also power to try all personal actions, as debt, trespass, slander, trover, actions on the case, &c. between party and party, within the liberty, which extends twelve miles about Whitehall. The judges of this court are the steward of the king's household, and knight-marshal for the time being; the steward of the court or his deputy, is generally an eminent counsel. It can try all causes, and sits every week, so that judgment can be obtained in a fortnight or three weeks. It has jurisdiction of all debts above as well as below 40*s*. But if a cause of importance is brought in this court, it is frequently removed into the court of King's Bench, or Common Pleas, by an *habeas corpus cum causa*. This cannot be done unless the debt is above 20*l*. The court would have a great deal of practice, on account of the expedition of it, if it were not confined by having only a fixed number of attornies.

MARSHMALLOW, in botany and medicine. See ALTHÆA.

MARSILEA, in botany, a genus of the Cryptogamia Miscellaneæ. Generic character: calyx common oval; corolla none; stamens, filaments none; anthers several, inserted round each pistil; pistil in each cell several; pericarpium none; seeds as many as there are pistils; receptacle membrane somewhat fleshy, clothing the cells internally. There are three species, natives of France, Italy, and the East Indies.

MARTIN (BENJAMIN,) in biography, was born in 1704, and became one of the most celebrated mathematicians and opti-

cians of his time. He first taught a school in the country; but afterwards came up to London, were he read lectures on experimental philosophy for many years, and carried on a very extensive trade as an optician and globe-maker in Fleet-street, till the growing infirmities of old age compelled him to withdraw from the active part of business. Trusting too fatally to what he thought the integrity of others, he unfortunately, though with a capital more than sufficient to pay all his debts, became a bankrupt. The unhappy old man, in a moment of desperation from this unexpected stroke, attempted to destroy himself; and the wound, though not immediately mortal, hastened his death, which happened the 9th of February, 1782, at 78 years of age.

He had a valuable collection of fossils and curiosities of almost every species; which, after his death, were almost given away by public auction. He was indefatigable as an artist, and as a writer he had a very happy method of explaining his subject, and wrote with clearness, and even considerable elegance. He was chiefly eminent in the science of optics; but he was well skilled in the whole circle of the mathematical and philosophical sciences, and wrote useful books on every one of them; though he was not distinguished by any remarkable inventions or discoveries of his own. His publications were very numerous, and generally useful; some of the principal of them were as follows:

"The Philosophical Grammar; being a View of the present State of Experimental Physiology, or Natural Philosophy," 1735, 8vo. "A New, Complete, and Universal System or Body of Decimal Arithmetic," 1735, 8vo. "The Young Student's Memorial Book, or Pocket Library," 1735, 8vo. "Description and Use of both the Globes, the Armillary Sphere, and Orrery, Trigonometry," 1736, 2 vols. 8vo. "System of the Newtonian Philosophy," 1759, 3 vols. "New Elements of Optics," 1759. "Mathematical Institutions," 1764, 2 vols. "Philologic and Philosophical Geography," 1759. "Lives of Philosophers, their Inventions, &c." 1764, 3 vols. "Miscellaneous Correspondence," 1764, 4 vols. "Institutions of Astronomical Calculation," 3 parts, 1765. "Introduction to the Newtonian Philosophy," 1765. "Treatise of Logarithms." "Treatise on Navigation." "Description and Use of the Air-pump." "Description of the Torricellian Barometer." "Appendix to the Use of the Globes." "Philosophia Britannica," 3 vols. "Principles of Pump-work." "Theory of the Hydrometer." "Description and Use of a Case of Mathematical Instruments." "Ditto of a universal Sliding Rule." "Micographia, or the Microscope" "Principles of Perspective." "Course of Lectures." "Optical Essays." "Essay on Electricity." "Essay on Visual Glasses, or Spectacles." "Horologia Nova, or New Art of Dialling." "Theory of Comets." "Nature and Construction of Solar Eclipses." "Venus in the Sun." "The Mariner's Mirror." "Thermometrum Magnum." "Survey of the Solar System." "Essay on Island Crystal." "Logorithmologia Nova," &c. &c.

MARTYNIA, in botany, so named in honour of John Martyn, F. R. S. professor of botany at Cambridge, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Bignoniæ, Jussieu. Essential character: calyx five cleft; corolla ringent; capsule woody, corticate, with a hooked beak, four-celled, two-valved. There are six species.

MARTLETS, in heraldy, little birds represented without feet, and used as a difference or mark of distinction for younger brothers, to put them in mind that they are to trust to the wings of virtue and merit in order to raise themselves, and not to their feet, they having little land to set their foot on.

MASON, a person employed under the direction of an architect in the raising of a stone building. The chief business of a mason is to make the mortar; raise the walls from the foundation to the top, with the necessary retreats and perpendiculars; to form the vaults, and employ the stones as delivered to him. When the stones are large, the business of hewing or cutting them belongs to the stone-cutters, though these are frequently confounded with masons: the ornaments of sculpture are performed by carvers in stones, or sculptors. The tools or implements principally used by them are the square, level, plumb-line, bevel, compass, hammer, chissel, mallet, saw, trowel, &c. Besides the common instruments used in the hand, they have likewise machines for raising of great burdens, and the conducting of large stones, the principal of which are the lever, pulley, wheel and axis, crane, &c. See LEVER, &c.

MASONS, *free and accepted*, a very ancient society or body of men, so called, either from some extraordinary knowledge of masonry or building, which they

are supposed to be masters of, or because the first founders of the society were persons of that profession. These are now very considerable, both for number and character, being found in every country in Europe, and consisting principally of persons of merit and consideration. As to antiquity, they lay claim to a standing of some thousand years. What the end of their institution is seems still a secret; and they are said to be admitted into the fraternity by being put in possession of a great number of secrets, called the mason's word, which have been religiously kept from age to age, being never divulged.

MASONRY, in general, a branch of architecture, consisting in the art of hewing or squaring stones, and cutting them level or perpendicular, for the uses of building: but in a more limited sense, masonry is the art of assembling and joining stones together with mortar.

MASSETER, in anatomy, a muscle which arises from the superior maxillary bone, and from the zygonia, and is inserted into the angle and coronoid process of the lower jaw.

MASSONIA, in botany, so named from Mr. Francis Masson, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Asphodeli, Jussieu. Essential character: corolla inferior, with a six-parted border; filaments on the neck of the tube; capsule three-winged, three-celled, many-seeded. There are four species, all of them found at the Cape of Good Hope.

MAST, a long round piece of timber, elevated perpendicularly upon the keel of a ship, upon which are attached the yards, the sails, and the rigging, in order to their receiving the wind necessary for navigation. A mast, according to its length, is either formed of one single piece, which is called a pole-mast, or composed of several pieces joined together, each of which retains the name of mast separately. A top-mast is raised at the head or top of the lower mast, through a cap, and supported by the trestle-trees. It is composed of two strong bars of timber, supported by two prominences, which are as shoulders on the opposite sides of the masts, a little under its upper end: athwart these bars are fixed the cross-trees, upon which the frame of the top is supported. Between the lower mast-head and the foremost of the cross-trees, a square space remains vacant, the sides of which are bounded by the two trestle-trees. Perpendicularly above this is the foremost hole in the cap, whose after-hole is solidly fixed on the head of the lower-mast. The top-mast is erected by a tackle, whose effort is communicated from the head of the lower-mast to the foot of the top-mast, and the upper end of the latter is accordingly guided into, and conveyed up through the holes, between the trestle-trees and the cap, as before mentioned; the machinery by which it is elevated, or, according to the sea-phrase, swayed up, is fixed in the following manner. The top-rope, passing through a block which is hooked on one side of the cap, and afterwards through a hole, furnished with a sheave or pully on the lower end of the top-mast, is again brought upwards on the other side of the mast, where it is at length fastened to an eye-bolt in the cap, which is always on the side opposite to the top-block. To the lower end of the top-rope is fixed the top-tackle, the effort of which, being transmitted to the top-rope, and thence to the heel of the top-mast, necessarily lifts the latter upwards parallel to the lower mast. When the top-mast is raised to its proper height, the lower end of it becomes firmly wedged in the square hole (above described) between the trestle-trees. A bar of wood or iron, called the fid, is then thrust through a hole in the heel of it, across the trestle-trees, by which the whole weight of the top-mast is supported. See Ship *building*.

MASTER *of arts*, is the first degree taken up in foreign universities, and for the most part in those of Scotland; but the second in Oxford and Cambridge; candidates not being admitted to it till they have studied seven years in the university.

Master *in chancery*. The masters in chancery are assistants to the Lord Chancellor and Master of the Rolls; of these there are some ordinary, and others extraordinary: the masters in ordinary are twelve in number; some of whom sit in court every day during the term, and have referred to them interlocutory orders for stating accounts, and computing damages, and the like; and they also administer oaths, take affidavits, and acknowledgments of deeds and recognizances. The masters extraordinary are appointed to act in the country, in the several counties of England, beyond ten miles distance from London; by taking affidavits, recognizances, acknowledgments of deeds, &c. for the ease of the suitors of the court.

Master *of the horse*, a great officer of

the crown, who orders all matters relating to the king's stables, races, breed of horses; and commands the equerries, and all the other officers and tradesmen employed in the king's stables. His coaches, horses, and attendants, are the king's, and bear the king's arms and livery.

MASTER *of the rolls*, a patent officer for life, who has the custody of the rolls of parliament, and patents which pass the great seal, and of the records of chancery, as also commissions, deeds, and recognizances, which, being made of rolls of parchment, gave rise to the name.

In absence of the chancellor he sits as judge in the court of chancery: at other times he hears causes in the rolls chapel, and makes orders; but all hearings before him are subject to appeal before the chancellor. He hath a writ of summons to parliament, and sits on the second wool-pack, next the lord chief justice.

In his gift are the six clerks in chancery, the examiners, three clerks of the petty bag, and the six clerks of the rolls chapel, where the rolls are kept. The rolls house is for his habitation, &c. By statute 23 George II. c. 25. 1200*l*. per annum is directed to be paid to the master of the rolls.

MASTER *of a ship*, the same with captain in a merchantman; but in a king's ship he is an officer who inspects the provisions and stores, and acquaints the captain of what is not good, takes particular care of the rigging and of the ballast, and gives directions for stowing the hold; he navigates the ship under the directions of his superior officer; sees that the log and log-book be duly kept; observes the appearances of coasts; and notes down in his journal any new shoal or rocks under water, with their bearing and depth of water, &c.

MASTER *at arms in a king's ship*, an officer who daily, by turns, as the captain appoints, is to exercise the petty officers and ship's company, to place and relieve centinels, to see the candles and fire put out according to the captain's orders, to take care the small arms are kept in good order, and to observe the directions of the lieutenant at arms.

MASTER *of the Temple*. Since the dissolution of the order of the Templars, the spiritual guide and pastor of the temple is so called, which was the denomination of the founder and his successors.

MASTER *of the wardrobe*, an officer under the Lord Chamberlain, who has the care of the royal robes, as well as the wearing apparel, collar, George, and garter, &c. He has also the charge of all former kings' and queens' robes remaining in the Tower, all hangings, bedding, &c. for the king's house, the charge and delivery of velvet and scarlet allowed for liveries. He has under him a clerk of the robes, wardrobe keeper, a yeoman, &c.

MASTER, *quarter*. See QUARTER.

MASTERS and SERVANTS. In London and other places, the mode of hiring is by what is commonly called a month's warning, or a month's wages; that is, the parties agree to separate, on either of them giving to the other a month's notice for that purpose, or in lieu thereof, the party requiring the separation to pay or give up a month's wages. But if the hiring of a servant be general, without any particular time specified, it will be construed to be an hiring for a year certain; and in this case, if the servant depart before the year, he forfeits all his wages. And where a servant is hired for one year certain, and so from year to year, as long as both parties shall agree, and the servant enter upon a second year, he must serve out that year, and is not merely a servant at will after the first year. If a woman servant marry, she must nevertheless serve out her term, and her husband cannot take her out of her master's service.

If a servant be disabled in his master's service, by an injury received through another's default, the master may recover damages for loss of his service. Which is the foundation also of an action where the servant, even though she is the child of the master, is seduced.

And a master may not only maintain an action against any one who entices away his servant, but also against the servant; and if, without any enticement, a servant leaves his master without just cause, an action will lie against another, who retains him with a knowledge of such departure.

A master has a just right to expect and exact fidelity and obedience in all his lawful commands; and to enforce this, he may correct his servant in a reasonable manner, but this correction must be to enforce the just and lawful commands of the master.

In defence of his master, a servant may justify assaulting another, and though death should ensue, it is not murder, in case of any unlawful attack upon his master's person or property.

Acts of the servant are, in many in-

stances, deemed acts of the master; and he is answerable for them when they are pursuant to his authority.

If a servant commit an act of trespass by command or encouragement of his master, the master will be answerable. But in so doing his servant is not excused, as he is bound to obey the master in such things only as are honest and lawful.

If a servant of an innkeeper rob his master's guest, the master is bound to make good the loss. Also, if a waiter at an inn sell a man bad wine, by which his health is impaired, an action will lie against the master: for his permitting him to sell it to any person is deemed an implied general command. In like manner, if a servant be frequently permitted to do a thing by the tacit consent of his master, the master will be liable, as such permission is equivalent to a general command.

If a servant is usually sent upon trust with any tradesman, and he takes goods in the name of his master upon his own account, the master must pay for them. And, also, if he is sent sometimes on trust, and at other times with money. But if a man usually deals with his tradesmen himself, or constantly pays them ready money, he is not answerable for what his servant may take up in his name; for in this case there is not, as in the other, any implied order to trust him.

So it is if the master never had any personal dealings with the tradesman, but the contracts have always been between the servant and the tradesman, and the master has regularly given his servant money for payment of every thing had on his account, the master shall not be charged. Or if a person forbid his tradesman to trust his servant on his account, and he continues to purchase upon credit, he is not liable.

The act of a servant, though he has quitted his master's service, has been held to be binding upon the master, by reason of the former credit given him on his master's account, and its not being known to the party trusting that he was discharged.

The master is also answerable for any injury arising by the fault or neglect of his servant when executing his master's business. But if there be no neglect or default in the servant, the master is not liable.

If a smith's servant lame a horse whilst shoeing him, or the servant of a surgeon make a wound worse, an action for damages will lie against the master, and not against the servant. But the damage must be done whilst the servant is actually employed in his master's service, otherwise he is liable to answer for his own misbehaviour or neglect.

A master is likewise chargeable, if his servant cast any dirt, &c. out of the house into the common street; and so for any other nuisance occasioned by his servants, to the damage or annoyance of any individual, or the common nuisance of his majesty's subjects.

A servant is not answerable to his master for any loss which may happen without his wilful neglect; but if he be guilty of fraud or gross negligence, an action will lie against him by his master.

A master is not liable in trespass for the wilful act of his servant, as by driving his master's carriage against another, done without the direction or assent of his master, no person being in the carriage when the act was done. But he is liable to answer for any damage arising to another from the negligence or unskilfulness of his servant acting in his employ, as for negligently driving against another.

MASTICATION, in medicine, the action of chewing, or of agitating the solid parts of our food between the teeth, by means of the motion of the jaws, the tongue, and the lips, whereby it is broken into small pieces, impregnated with saliva, and so fitted for deglutition and a more easy digestion.

MASTICH, in the materia medica, when pure, is in the form of little round drops, or tears, of a very pale amber; a piece recently broken is quite transparent, but by exposure to the air it becomes somewhat inclining to the form of powder. When slightly warmed, this resin has a faint and rather pleasant odour, which becomes stronger and more grateful when it is melted. In its chemical properties, mastich does not much differ from the other resins. If it is digested in alcohol, it is separated into two portions; the one soluble in the spirit, the other insoluble: the former composes four-fifths of the whole, and is pure resin; the latter, in most of its properties, closely resembles caoutchouc. In Turkey, mastich is in great request among women as a masticatory; and the produce of China is appropriated solely to the use of the Emperor's seraglio. In other countries it is employed, medically, in fumigations; and by painters and other artists, in the composition of the tougher kinds of varnishes.

MASTOIDES, in anatomy, the same with mammillaris; being applied to such processes in the body as have the appearance of breasts or dugs, arising in a broad basis, and terminating in an obtuse top. Mastoides is sometimes applied to the muscle which stoops the head, proceeding from the neck-bone and breast-bone, and terminating in the process of the mammiformis. See MAMMILLARY *gland*.

MATCH, a kind of rope slightly twisted, and prepared to retain fire for the uses of artillery, mines, fire-works, &c. It is made of hempen tow, spun on the wheel like cord, but very slack; and is composed of three twists, which are afterwards again covered with tow, so that the twists do not appear: lastly, it is boiled in the lees of old wines. This, when once lighted at the end, burns on gradually and regularly, without ever going out, till the whole be consumed: the hardest and driest match is generally the best.

MATERIA *medica*. It is a subject of curiosity rather than of use, to enquire by what means mankind are induced, in the first instance, to have recourse to substances, when in a state of disease, which, for the most part, they abhor and fly from when in a state of health; and how they came to discern that in these substances chiefly, nature has treasured up the remedies of sickness, the restoratives of a vitiated or debilitated constitution. From whatever source this knowledge has been derived, we feel it daily to be a knowledge of a very important character, and we are sensible of its having been very generally diffused at a very early period of ancient history. Accident, in the first instance, and experience confirming the result of some fortunate discovery, were perhaps the chief foundation of therapeutic science in the simplest and rudest ages of the world. Yet the whole can by no means be traced to this source, for the general fallacy of experience is sufficient to prove, that it has had but a very small share in establishing the virtues which have been ascribed to most medicines; and it was probably from a too frequent disappointment in practice, from palpable proof of the uncertainty of those remedies which are recommended by the ancients, that physicians in times comparatively modern have been induced to seek for means, not only for ascertaining more exactly the qualities of established medicines, but of investigating the virtues of substances altogether new and untried.

Hence unquestionably the union of chemistry with the art of healing; for among the earliest chemists we meet with the first attempts at departing from the usual catalogue of medicines in pursuit of a new list. Paracelsus led the way, by introducing the absurd notion of astral influences and of signatures; to which succeeding and more rational chemists suggested the utility of a chemical analysis. The doctrine of astral influences and of signatures, has been altogether exploded for a long time, though we still trace certain vestiges of its former existence in many of our latest publications on the Materia Medica. Chemical analysis, as it ought to do, has completely triumphed over the two former systems, and is daily extending its enquiries. To arts, manufactures, and commerce, these enquiries have been pre-eminently useful, nor have they been without their benefit to medicine; yet the benefit resulting from this last application has by no means been equal to that which has resulted to the two former.

The means then resorted to in the present day for determining substances to be remedial or medicinal, or, in other words, the previous steps to their introduction into the Materia Medica, are their own sensible qualities, their botanical affinity, their chemical examination, and general experience.

Having introduced them into the medical catalogue, our two next subjects of consideration are, their classification or arrangement, and the best mode of employing them, whether simply, and on account of their own specific virtues, or in connection with other substances, by which their proper qualities are so intermixed with the qualities of the other substances employed, as to acquire an increased, a diminished, or altogether a new action; and consequently to be productive of a different result.

The former consideration alone belongs, strictly speaking, to the present article; the latter constituting the proper subject of pharmacy or compound medicine. For the theory and practice, therefore, of combining and compounding medicinal substances, we refer our readers to the article PHARMACY; and shall here confine ourselves, as strictly as we may be able, to the materials actually employed in medicine, on account of their own supposed inherent virtues, and which for the most part are denominated simples.

What ought to be classification of these

materials? This is a question which has often been agitated, and almost as often answered in a different manner: whence the arrangement of different writers is as different as possible, as founded upon some supposed superior advantage, or even the mere fancy of the author himself. The most simple arrangement is that of an alphabetic form, and it has taken place in most of the dispensatories and pharmacopœias of modern times; but it conveys no practical information, indicates no specific virtue, communicates no scale of comparative power. Another arrangement is that founded upon the quarter or kingdom from which the material is derived; and of course under this system the Materia Medica is divided into the three grand classes of animal, vegetable, and mineral substances. Yet this arrangement does not appear to be of much more advantage than the preceding; the plan is even less simple, and the knowledge it communicates is too trivial to be of any importance. Another, therefore, and a better distribution is founded upon the sensible and more obvious qualities of the substances employed in medicine; from their being acid, absorbent, glutinous, unctuous, astringent, saccharine, acrid, aromatic, bitter, emetic or cathartic. For this classification we are indebted to Cartheuser; it is highly ingenious, and so far as it is applicable, of considerable utility. But it labours under the defect of being incapable of general application.

There are many simples, for example, and those even of great power and activity, in which we can distinguish no predominant sensible quality; there are many, again, in which various qualities are so equally united, that they have just the same claim to a position under one class or order as under another; and there are many, also, which, though similar in their sensible qualities, are very dissimilar in their effects upon the animal frame: thus, though gentian and aloes agree in possessing a bitter taste, and sugar and manna in being sweet, their medical virtues are widely different. Accordingly, Cartheuser himself is compelled to deviate ocasionally from his general plan, and to found a part of his division on the medicinal effects of his materials; introducing not only a class of purgatives and emetics, but of vaporose inebriants and narcotics; under which last class he arranges tobacco, elder-flower, saffron, opium, and poppy-seeds, substances, certainly, very discordant in all the qualities that relate to medicinal intentions.

The last division we shall notice is that of Vogel, who has classified his materials according to their effects on the human body. Some are found to have the property of rendering the solid parts of the frame more lax than before, and are hence denominated relaxing medicines; others possess a directly contrary power, and are consequently called indurating medicines. A third kind are found to excite inflammation in the part to which they are applied, and are therefore named inflammatory; while a fourth, from being perceived to increase or diminish the vigour of the body, or what is called the tone of the solids, have acquired the name of tonics in the first instance, and sedatives in the second. Some, again, are conjectured neither remarkably to increase nor diminish the tone of the solids; but to perform their office either by correcting some morbid matter in the body, or by evacuating it; in the former case they are called alterants, in the latter evacuants.

These are the general divisions or classes into which simple medicines are partitioned under this system; but when we begin to consider their virtues more particularly, a variety of inferior divisions must necessarily ensue. Thus, of the relaxing medicines, some, when externally applied, are supposed merely to soften the part; and in such case are called emollients; while others, which are supposed to have a power of augmenting the disposition of the secernents of an inflamed part to the secretion of pus, are called maturants or suppuratives. Sedative medicines, that have the power of assuaging pain, are denominated paregorics; if they altogether remove or destroy pain, they are called anodynes; if they take off spasm, antispasmodics; if they produce quiet sleep, hypnotics; if a very deep and unnatural sleep, together with considerable stupefaction of the senses, narcotics. Tonic medicines, in like manner, obtain the name of corroboratives, analeptics, or nervines, when they slightly increase the contractile power of the solids; but of astringents, or adstringents, if they do this in a great degree. Some of this order of medicines have been supposed to promote the growth of flesh, to consolidate wounds, and restrain hæmorrhages, and hence the names of sarcotics and traumatics, or vulneraries; names, however, which may well be dispensed with, as the quality is very questionable, and perhaps altogether erroneously ascribed. Other astringents, again, are denominated repellent, discu-

tient, stimulant, or attractive, according to the respective modes by which they are conceived to produce one common effect. Medicines of the inflammatory tribe, are, in like manner, divided into vesicatories or blisters, if by their application they raise watery bladders on the skin; cathæretics, escharotics or corrosives, if they eat into and destroy the substance of the solid parts themselves; and rubefactive or rubefacient, if possessed of less power than the vesicatories, they merely produce a redness on the part to which they are applied, by increasing the action of a part, and stimulating the red particles of the blood into vessels which do not naturally possess them. The alterant tribe is divided into absorbents, antiseptics, coagulants, resolvents, calefiants, and refrigerants, according to the peculiar mode by which the different individuals of this tribe are supposed to operate. The evacuants are generally subdivided from the nature of the humour they are supposed to discharge: emetics, if they evacuate the contents of the stomach by vomiting; cathartics, if they induce purging; laxatives, if they produce a moderate discharge of feces without pain or sickness; eccoprotics, if the discharge be greater, but still confined to the common nature of the feces themselves. Thus again they are named diaphoretics, if they promote the expulsion of humours through the pores of the skin with a small increase of action; sudorifics, if the increase of action be greater, and the discharge more copious. Such as excite urine are called diuretics; such as produce evacuation from the glands of the palate, mouth, and salivary ducts, salivating medicines; those that promote the discharge of mucus from the throat, apophlegmatics; those that evacuate by the nose, ptarmics; errhines, sternutatories; and those which promote the menstrual discharge, emenagogues. To this order, also, some writers reduce those medicines which expel any preternatural bodies, as worms, stones, and flatus or confined air: of these the first are called anthelmintics; the second, and especially when directed to the bladder, lithontriptics; and the third, carminatives.

Such is the general outline of those who have adopted this kind of system. But it must be obvious that, though the general outline be the same, it may submit to a great variety of modifications; and hence, again, the writers who have made choice of this system, and founded their classifications upon the effects produced by the articles of which they have treated upon the human body, have arranged it in various ways, according to their respective ideas of superior utility or convenience. Hence the classes of Cullen amount to twenty-three; those of Darwin to not more than seven; while others have given us twelve, fourteeen or fifteen, according to their own fancy.

The twenty-three classes of Dr. Cullen are as follow:

Astringents	Antacids
Tonics	Antalkalines
Emollients	Antiseptics
Corrosives	Errhines
Stimulants	Silagogues
Narcotics	Expectorants
Refrigerants	Emetics
Antispasmodics	Cathartics
Diluents	Diuretics
Attenuants	Diaphoretics
Inspissants	Menagogues.
Demulcents	

The seven classes of Dr. Darwin are the ensuing:

Nutrients	Invertents
Incitants	Revertents
Secernents	Torpents.
Absorbents	

It will appear, even upon a superficial examination of the former of these classifications, that the first division is unnecessarily diffuse; that some of the divisions might be introduced under one common head, as, for example, those of emollients and demulcents; diluents and attenuants; and that for one or two of them there is little foundation in nature. We particularly allude in this last instance to the antalkalines, which are obviously only introduced as a sort of graceful contrast to the antacids; and concerning which the writer himself observes, "had it not been to give some appearance of system, and from my complaisance to Dr. Boerhaave, who treats *de morbis ex alkali spontaneo*, I should not have admitted of this chapter; for I am well persuaded that no alkaline salt, in its separate state, ever exists in the blood vessels of the living human body." This is not the only instance, however, in which we find men of judgment and deserved reputation consenting to propagate errors from the mere love of system, or from attachment to names of extensive celebrity. Happy would it be for us, that all who thus act should avow their error, like the author before us, and thus put the remedy by the side of the evil!

The classification of Dr. Darwin, how-

ever, labours under still stronger objections. Instead of being too diffuse, it is too contracted, for we may defy the warmest supporter of the Darwinean school to simplify and arrange the whole of what is included in the preceding classification, or that ought to be so included, under the present. But it has a fault still more prominent; and that is, it is adapted to an individual nosology, we mean the nosology of the author himself; and this a nosology, which in some of its divisions is perhaps founded on mere fancy, and consequently has no chance of a permanent or general adoption. His invertentia and revertentia depend upon actions, which to say the least of them are highly doubtful, and have for some years been gradually sinking into disbelief.

Between these two extremes we have had a variety of arrangements of late years, one of the best of which, perhaps, is Dr. Kirby's, published in a small tract, entitled, "Tables of the Materia Medica," which, with a chemical and a miscellaneous division, consists of eighteen classes; but to both of which we cannot but object; to the first, as it enters too deeply into the department of pharmacy, for a mere list of the materials of medicine; and to the second, as evincing a carelessness, or want of methodizing talent, which we should not have expected, and a total departure from every system whatever. We shall nevertheless avail ourselves of its general merit as far as we may be able, and endeavour to correct its deficiencies.

There is, however, another point to which we must advert before we proceed to our classification: and that is the nomenclature by which the different substances ought to be distinguished. Till of late, from the use of different nomenclatures by different colleges of medicine, and an absurd intermixture of several of them by some writers, the whole has been a scene of perplexity and confusion. Within the last six or seven years, however, a disposition has been progressively evinced to simplify and generalize the technology, and render the descriptions more accurate. The language of Linnæus has been resorted to as by common consent, throughout the three kingdoms of animals, vegetables, and minerals; and though the chemical vocabulary of Lavoisier has not yet been generally introduced, it is daily gaining ground in the publications of individual writers, and has been admitted in its utmost latitude into one or two of our collegiate pharmacopœias. The college of Edinburgh, as it has long led the way as a medical school, has also taken the lead in this instance, and has the honour of having first composed a pharmacopœia, in the pure and unmixed language of science, by its last edition, published in November 1804. The Dublin College has followed its example, by a very excellent specimen alterum, published about six months ago; and at length the College of London, stimulated by such noble incentives, has also roused itself, and is on the point of reediting its own pharmacopœia, with the modern improvements, of the greater part of which we are even now able to avail ourselves, from the possession of one of the few copies which have been worked off as specimens, and circulated amidst the members of the college, and the best informed medical practitioners, for the purpose of marginal remarks, before the publication of the work in a finished state. In its general nomenclature, it will be found not to vary essentially from the nomenclature of the Edinburgh pharmacopœia, and especially in that part of it which relates to the Materia Medica, the immediate object before us.

We freely confess our surprise, that, from the errors resulting from a promiscuous use of weights and measures, nothing either general or very decisive, has been attempted by either of the two new, or the projected pharmacopœia. It would have added largely to the reputation of the intended edition of the London College, if it had adopted the decimal and applicable mensuration of the French Institute, at the same time that it consented to admit the French nomenclature. It has not, however, been altogether inactive upon this subject, for it has thrown away the unscientific and indecisive measure of drops, and has instituted that of grains in its stead, so that a drop in the forthcoming edition will be found to answer to a grain, in the same manner as a pint answers to a pound, the Troy weight being still continued as heretofore: and of course a scruple will intimate twenty grains of liquids as well as of solids. We shall only observe further, that the Edinburgh College has expressed an intractable abhorrence of all measures of medicines whatsoever, and in consequence has rejected their use in every instance: so that in the Edinburgh forms, the liquids of every kind are supposed to be employed by weight alone.

In the ensuing classification we have been anxious to give our readers a gene-

ral and concentrated view, as far as we have been able, not only of the substances employed, but of the mode and preparation in which they are exhibited by the different pharmacopœias at present extant; we may be told, perhaps, that we are hereby, in some measure, entrenching upon the province of Pharmacy, properly so called. We are not insensible to the remark: but we hereby gain an advantage which no other plan could present to us; we offer at one and the same time a table of comparative statements, and show the various forms in which the same material becomes an official drug. We have also been anxious to exhibit, in every instance, a glance at the common dose for adult age, as well as to specify in terms, as abbreviated as possible, the name of the country in which the different articles exist indigenously; the part or organ of the substance employed; and the disease in which it is supposed to be efficacious. The classification is as follows, and every class is subdivided as far as possible into an animal, a vegetable, and a fossile section.

Emetics	Refrigerants
Expectorants	Astringents
Diaphoretics	Tonics
Diuretics	Stimulants
Cathartics	Antispasmodics
Emmenagogues	Narcotics
Errhines	Anthelmintics
Sialagogues	Absorbents
Emollients	

CLASS I. EMETICA.

SECT. I. ANIMALIA.

Murias Ammoniæ. Edin.
Sal. ammoniacum. Lond. Dub.
Brittannia.
Aq. carbonatis ammoniæ. E.
Aq. ammoniæ. L.
Liquor alkali volat. mitis. D. } dr. 1—2.

SECT. II. VEGETABILIA.

Anthemis nobilis. E.
Chamæmelum. L. D.
Brit. Flos. Infus. dr. 2—4. ad. aq. lib. ½.
Asarum europæum. E.
Asarum. L. D.
Brit. Ital. Folia. Pulv. dr. ½—1.
Centaurea benedicta.
Carduus benedictus. L.
Insul græc. Folia. infus. vel decoct.
Cephælis ipecacuanha.
Ipecacuanha. L. E. D.
India occid. Brasil. Radix. Pulv. gr. 15—25.
Vinum ipecacuanhæ. L. E. D. unc. 1—2.
Nicotiana Tabacum. E.
Nicotiana. L.
America. Folia. Fum. Cataplasm.
Olea europæa. E.
Oliva. L. D.
Europ. merid. Fructus oleum express.
Ad Venena.
Scilla maritima. E.
Scilla. L. D.
Eur. merid. Rad. Pulv. gr. 4—10.
Acetum. Scillæ marit. E.
Acet. scillæ. L. D. unc. ½—1.
Sinapis alba. E.
Sinapi. L. D.
Brit. Seminis pulvis aqua commixt. dr. 1.

SECT. III. FOSSILIA.

Sulphas Cupri. E.
Cuprum vitriolat. L. D.
Brit. Solut. gr. 2—5.
Ad Venena.
Sulphuretum antimonii. E.
Antimonium. L. Stibium. D.
Brit.
Oxidum Antimonii cum Sulphur. vitrificat E.
Antimonium vitrificatum L.
Vinum Antimonii L.
Tartris Antimonii E.
Antimonium tartarisatum L.
Tartarum Stibiatum. D. } gr. 1-4. dos. repetit.
Vinum Tartrit. Antimon. E. unc. ½—1½.
Antimon. tartar. L.
Tartari stibiat. D. dr. 2—6.
Zincum E.
Sulphas Zinci E.
Zincum vitriolatum. L. D. } gr. 10—30.

CLASS II. EXPECTORANTIA.

SECT. I. VEGETABILIA.

Cephælis Ipecacuanha. Pulv. gr. 1. 3tia aut 4ta qu. hor.
Peripneumon. noth. Asthma.
Nicotiana Tabacum. Fumus.
Scilla maritima.
Acet. Scil. maritim. dr. 2—4.
Syrup Scill maritim. E.
Oxymel Scillæ. L. D.
Tinctura Scillæ. L. gt. 10—dr. 1.
Pilulæ Scillæ. L. D.
Scilliticæ. E. } gr. 10—15.
Conserva Scillæ, L. gr. 30—40.
Allium sativum. E.

Allium. L. D.
Eur. merid. Rad. recens. dr. 1—2.
Syrupus Allii. L. coch. 1. subinde.
Ammoniacum. E. L. D.
India. Gum-resin. Pil. Mist. gr. 10—20. dos. rep.
Lac Ammoniaci. L. unc. 1—2. dos. rep.
Arum maculatum. E.
Arum. L.
Brit. Rad. recens.
Conserv. Ari. L. dr. ½—1.
Colchicum autumnale. E.
Colchicum. L.
Brit. Rad. recens.
Syrupus Colchici autumnal. E. } dr. 2—
Oxymel Colchici. L. } unc. 1.
Ferula Asa fœtida. E.
Asa fœtida. L. D.
Persia. Gum-resin. Pil. mist. gr. 10—15. dos. rep.
Lac Asæ fœtidæ. L. unc. 1—2. dos. rep.
Hyssopus officinalis.
Hyssopus. D.
Brit. Herba.
Marrubium vulgare. L.
Brit. Folia. Syrup.
Myrrha. L. E. D.
Arab. Abyssin. Gum-resin. Pul. Pil. gr. 10—dr. ½.
Pimpinella Anisum. E.
Anisum. L. D.
Asia. Semin. Infus.
Ol. volat. Pimpinell. Anisi. E.
Essent. Anisi. L. gr. 2—6.
Polygala Senega. E.
Seneka. L. D.
Amer. Rad.
Decoctum. Polygal. Senegæ. E. unc. 1—1½.
Cynanch. tracheal. Pneumon.
Styrax Benzoin. E.
Benzoinum. D.
Benzoe. L.
Sumatra. Balsam.
Acidum Benzoicum. E.
Sal Benzoini. D. } gr. 1—2. dos.
Flores Benzoes. L. } repet.
Tinct. Benzœis. compos. L. gt. 15—30.
Alcohol.
Spirit. Vini rectificat. L. D.
Æther Sulphuricus. E. } forma va-
vitriolicus. L. D. } poris.
Asthma.

SECT. II. FOSSILIA.

Sulphuretum Antimonii.
Tartris Antimonii. gr. ⅓—½. subinde.
Vinum Tartrit. Antimonii. E dr. 1—2.
Antimonii tartaris. L. D. gt. 30—d. 1.
Sulphuretum Antimonii precipitat. E*.
Sulphur Antimonii præcip. } gr. 3-5.
L. Stibii rufum. D. }
Sulphur sublimatum. E.
Flores Sulphuris. L. D.
Sulphur sublimat. lotum. E. } gr. 15—
Flores Sulphuris loti. L. D. } dr. ½.
Oleum Sulphuratum. L. D. E. gt. 10—20.
Petroleum Sulphuratum. L.
Trochisci Sulphuris. L.
Asthma, &c.

* This should have been called *Hydrosulphuretum.*

CLASS III. DIAPHORETICA.

A. *Mitiora.*

SECT. I. ANIMALIA.

Murias Ammoniæ.
Aqua Carbonat. Ammoniæ. gt. 50.
Carbonas Ammoniæ. E. }
Ammonia præparata. L. } gr. 5—10.
Alkali volatile mite. D. }
Alcohol Ammoniatum. E.
Spirit. Ammoniæ. L. } gt. 30—
Alkali volatil. D. } dr. 1.

SECT. II. VEGETABILIA.

Anthemis nobilis.
Infus. calid.
Centaurea Benedicta.
Ibid.
Myrrha.
Pulv.
Allium sativum.
Acidum Acetosum.
Acetum. L. D
Serum lactis Aceto coacti.
Rheumatism.
Acidum Acetosum destillat. E.
Acetum distillatum. L. D.
Aqua Acetitis Ammoniæ. E. }
Ammoniæ acetatæ. L. } dr. 3-6.
Liq. Alhali volat. acetat. }
Arctium Lappa. E.
Bardana. L. D.
Brit. Rad. Decoct.
Artemisia Abrotanum.
Abrotanum. L.
Eur merid. Folia. Infus.
Aristolochia Serpentaria. E.
Serpentaria. L. D.
Americ. Rad. Pulv. gr. 20—30. 6ta quaq. hor.

Tinctur. Aristoloch. Serpentar. E. Sepentar L. } dr. 3-6.
Daphne Mezereum. E.
Mezereum. L.
Mezereon. D.
Eur. septentr. Radicis cortex. Pulv. gr. 1.
Decoctum Daphnes Mezerei. E. unc. 1—2.
Syphil. Morb. cutan.
Dorstenia Contrayerva. E.
Contrayerva. L. D.
Amer. merid. Rad. Pulv. gr. 30—40.
Decoct.
Febr. Cynanch.
Pulv. Contrayerv. comp. L. gr. 30—40. 4ta. qu. hor.
Fumaria officinalis.
Fumaria. D.
Brit. Herba. Infus.
Laurus Sassafras. E.
Sassafras. L. D.
Amer. sept. Ling. Rad. Cort. Decoct.
Salvia officinalis. E.
Salvia. L. D.
Eur. mer. Folia. Infus. ad libitum.
Sambucus nigra. E.
Sambucus. L. D.
Brit. Baccæ. Succus expressus.
Succus baccæ Sambuc. spissat. L.
Smilax Sarsaparilla. E.
Sarsaparilla. L. D.
Ind. Occ. Rad. Decoct.
Decoctum Smilac. Sarsaparill. E. Sarsaparill. L. D. } lib. 1. — in die.
compos. L. Ibid.
Ad morbos cutan.
Solanum Dulcamara. E.
Dulcamara. E.
Brit. Stipites. Decoct.
Supertartris Potassæ. E.
Crystalli Tartari. L. D.
Gallia, &c. Pulv. Solut. scr. 1—dr. 1. sæpius in die.

B. *Fortiora.*

SECT. I. ANIMALIA.

Moschus moschiferus. E.
Moschus. L. D.
Asia. Mætries prope Umbilic. collecta. Bol.
Haust. gr. 10—20.
Mistura moschata. L. unc. 1—2.

SECT. II. VEGETABILIA.

Aconitum neomontanum.
Aconitum napellus. L. E. D.
Eur. mer. Folia. Pulv. Tinctur. gr. ½—2.
Succus spissat. Aconit napell. E. gr. ½—2.
Rheumat. Podagr. Paralys.
Guaiacum. officinale, E.
Guaiacum. L. D.
Ind. Occ. Ling.
Cort. Dec. Gum-resin. Pulv. Pil. Emuls. gr. 10—30.
Decoct. Guaiaci offic. comp. E. lib. ½—1. in die.
Ad. morb. cutan.
Tinctur. Guaiac. offic. dr. 2—4.
Ammoniæ. E. Guaiaci. L. volatilis. D. } dr. 1—3.
Rheumatism.
Laurus Camphora. E.
Camphora. L. D.
Ind. Orient. Bol. Mist. gr. 5—20.
Mistura Camphorata, L. unc. 2—4.
Emulsio Camphorata, E. unc. 1—3.
Papaver somniferum. E.
Pap. album. L. D.
Opium.
Asia. Succus spiss. capsul. Pil. Pulv. gr. 1—2.
Tinctura Opii. L. E. D. gt. 25—50.
Tinct. Opii camphorat. L. dr. 2—6.
Ammoniata. E. dr. 1—1½.
Pulv. Ipecac. et Opii. E. compos. L. D. } gr. 10—20.
Rhododendron Chrysanthum. E.
Siberia. Fol. Summit. Decoct. dr. 2—4. ad lib. 7.—unc. 1—2. bis in die.
Rheumat. Podagr.

SECT. III. FOSSILIA.

Sulphuretum Antimonii.
Tartris Antimonii. gr. ¼. 6ta. qu. hora.
Vinum Tartrit. Antimon. E. dr. 2.
Antimon. tartar. L. dr. 1.
Sulphuret. Antimon. præp. gr. 1—2.
Sulphur Stibii fuscum. D. Gr. 1—1½.
Oxidum Antimon. cum phosphate Calcis. E. Pulvis Antimonialis L. Stibiatus D. } gr. 4—6. 4ta aut 6ta quaq. hor.
Antimonium calcinatum L. gr. 10—15.
Calx Stibii præcipitat. D.
Febres. Cynanchen. Pneumon. Rheumat. Variol. Rubeol. Scarlatin. Catarrh.
Dysenter, &c.
Sulphur sublimatum.
Sulph. sublimat. lat E. præcipitat. L. } gr. 12—30.
Hydrargyrum.

Hydrargyrus. L. E. D.
Hungaria, &c.
Hydrargyr. purificat. L. E. D.
Submurias Hydrargyr. E.
Calomelas. L.
Hydrarg. muriat. mit. sublim. D. } gr. 1. omn. nocte.
Rheumat.

CLASS IV. DIURETICA.

SECT. I. ANIMALIA.

Lytta vesicatoria.
Meloe vesicatoria. E.
Cantharis. L. D.
Eur. mer. Pulv. gr. ½.—1. 4ta vel 6ta qu. hor.
Tinctur. Meloes vesicat. E.
Cantharid. L. gt. 10—20.
Ischur. Hydrop.
Oniscus Asellus. E.
Millepedes. L.
Brit.

SECT. II. VEGETABILIA.

Asarum europæum. Rad. Decoct.
Hydrop.
Nicotiana Tabacum. Infus. unc. 1. ad lib. 1. gt. 60—80.
Hydrop. Dysur.
Scilla maritima. Pulv. gr. 1—2. bis terve in die.
Tinctur. Scilæ. gt. 20—30.
Hydrop.
Allium sativum.
Colchicum autumnale.
Syrup. Colchici. E.
Oxymel Colchica. L.
Acetum Colchici. D. } dr. 1—4. bis terve in die.
Hydrop.
Polygala Senega.
Decoct. Polygal. Seneg. unc. 1—1½.
Acidum Acetosum.
Acetis Potassæ. E.
Kali acetatum. L.
Alkali vegetabile acetat. } ser. 1—4.
Hydrop. Icterum.
Daphne Mezereum.
Decoct. Daphn. Mezerei. unc. 1—2.
Smilax Sarsaparilla.
Decoct. Sarsaparill. com. ad libit.
Solanum Dulcamara. Decoct.
Supertartris Potassæ Solut. unc. ½. in die.
Hydrop.
Allium Cepa.
Cepa. D.
Cult. Rad. recens ad libit.
Cissampelos Pareira.
Pareira brava. L. D.
Ind. Occid. Rad.
Cochlearia Armoracia. E.
Raphanus rusticanus. L. D.
Brit. Rad. recens. Infus.
Hydropes.
Copaifera Officinalis. E.
Balsamum Copaiva. L. Copaiba. D.
Ind. Occ. Amer. Resin. Gutt. Emuls. gtt. 20—60.
Cynara Scolymus.
Cin. Scolymus. E.
Cinara. L. D.
Eur. mer. Folia. Succ. express. unc. ½—1. bis in die.
Hydrop.
Digitalis purpurea. E.
Digitalis. L. D.
Brit. Fol. Pulv. gr. 1. bis in die. Infus. Decoct.
Hydrop.
Juniperus communis.
Juniperis. L. D.
Brit. Bacc. scr. 1—dr. ½. Cacumen. Infus. ad libit.
Spir. Juniper. commun. comp. E.
compos. L. D. } unc. ½—1. dilut. subind.
Ol. Juniper. L. D.
commun. E.
Juniperus Lycia.
Olibanum. L. D.
India. Gum-resin.
Leontodon Taraxacum.
Taraxacum. L. D. Rad.
Pinus Sylvestris. E.
Terebinthina vulgaris. L. D.
Brit. Resina et ol. volat. Gutt. Enema. Pill. gr. 15—20.
Ol. Volat. Terebinth rect. gtt. 20—30.
Pinus Larix.
Terebinthina Veneta. L. D.
Brit. Resina. Enema. Pill.
Spartium scoparium. E.
Genista. L. D.
Brit. Sem. Cacum. Decoct. ad libit.
Ulmus campestris. E.
Ulmus. L. D.
Brit. Cort. intern. Decoct.
Decoct. Ulmi. L. unc. 4—8. sæpius in die.
Ad morb. cutan.

SECT. III. FOSSILIA.

Hydrargyrum.
Murias Hydrargyri. E.
Hydrargyrus muriatus. L.
Hyd. mur. corros. D. } gr. ⅛—¼.
Ad morb. cutan.
Nitras Potassæ. E.
Nitrum. L. D.
India. Pulv. gr. 5—15.
Nitrum purificat. E. L. u. s.
Acidum Nitrosum. L. E. D. dr. 1—2. ad Aquæ lib. 1. in die.

Spir. æther. nitros. L. E. D. gtt. 30—60. sæp. in die.

CLASS V. CATHARTICA.

A. *Mitiora.*

SECT. I. ANIMALIA.

Mel. L. E. D.
Brit.
Mel despumatum. E. L. D.

SECT. II. VEGETABILIA.

Anthemis nobilis.
Decoct. Anthemid. nobil. E. Enema.
Olea europæa. Oleum. Enema.
Supertartris Potassæ. Pulv. dr. 2—4.
Tartris Potassæ. E. } dr. 2—6.
Kali tartarisatum. L.
Alkali vegetabile tartarisat. D.
Tartris Potassæ et Sodæ. E. } unc. 1–2.
Natron tartarisatum. L.
Sal Rupellense. D.
Ad Febres. Phlegmas. Hæmorrhag. Comata. Colicam.
Choleram. Hydropes. Icterum.
Cassia fistula. E.
C. fistularis. L. D.
Ind. Or. et Occ. Fruct. Pulpa. ad libit.
Electuar. Cassiæ. L. } unc. ½—1.
fistul. E.
C. Senna. E.
Senna. L. D.
Ægypt. Folia. Pulv. Infus.
Pulvis Sennæ composit. L. dr. ½—1.
Febres, &c.
Electuar. Cassiæ Sennæ. E. } dr. 2—6.
Sennæ. L. D.
Infusum Sennæ. Simpl. L. } unc. 1—3.
Sennæ. D.
tartarisat. L.
Infus. Tamarind. Indic. cum Cass. Senna E. unc. 1—3.
Tinctura Sennæ. comp. E.
Sennæ. L. D. unc. ½—1½.
Colicam.
Ficus Carica.
Carica. L. D.
Eur. mer. Fruct.
Fraxinus Ornus. E.
Manna. L. D.
Eur. mer. Succ. concret. Solut. Elect. unc. 1—1½.
Syrupus Mannæ. D.
Prunus Domestica. E.
Pr. Gallica. L. D.
Eur. mer. Fruct. ad libit.
Rosa Damascena. L. D.
Rosa centifolia. E.
Eur. mer. Petala.
Aq. Rosæ centifolia. E.
Rosæ. L. D.
Syrup. Rosæ. centifol. E.
Rosæ. L. D.
Saccharum officinale. E.
Sacch. non. purificat. L. D.
Ind. Occid. Succ. spissat.
Tamarindus Indicus. E.
Tamarindus. L. D.
Ind. Occ. Fruct. Pulpa. unc. 1—2. Infus.
Viola odorata. E.
Viola. L. D.
Brit. Petala. Infus.
Syrupus Violæ odoratæ. E.
violæ. L. D.

SECT. III. FOSSILIA.

Sulphur sublimatum.
Sulphur. sublimat. lotum. dr. 1—2
Ad Hæmorrhag. Morb. cutan. Obstipat.
Sapo Hispanus. L. E. D.
Hispan. Pil. Enema.
Icterum.

B. *Fortiora.*

SECT. I. ANIMALIA.

Cervus Elaphus. E.
Cervus. L. Cornu cervinum. D.
Phosphas Calcis.
Phosphas Sodæ. E. unc. 1—2.

SECT. II. VEGETABILIA.

Nicotiana Tabacum. Fum. Infus. pro Enemat.
Colicam Obstipat.
Sambucus nigra. Cortex interior Decoct. unc. 1. ad lib. 1. in die.
Hydrop.
Pinus sylvestris } Terebinthina Enemat.
Larix.
Aloe perfoliata. E.
Aloe Soccotrina.
A. Hepatica.
A. Cabalina. L. E. D.
Asia. Ind. Occ. Africa. Gum resin. Pil. gr. 5—20.
Pulv. Aloes cum Canella. L. gr. 8—20.
Pilulæ Aloeticæ E. D. } gr. 10—20.
Aloes compos. L.
Aloes cum Colocynth. L. gr. 10—29.
Vinum Aloes Soccotrin. E. unc. 1—2.
Aloes. L. Aloetic. D. unc. ½—1.
Tinctura Aloes socotrin. E. } unc. ½—1½.
Aloes. L.
Dyspeps. Hypochondrias. Chloros.

Icter. Obstipat.
Bryonia alba. E.
Bryonia. D.
Brit. Rad. Decoct. Pulv. scr. 1—2.
Maniam. Hydrop.
Convolvulus Jalapa. E.
Jalapium. L.
Jalapa. D.
Amer. Rad. Pulv. Bolus. gr. 15—30.
Pulvis Jalapæ compos. E. dr. $\frac{1}{2}$—1.
Extract. Rad. Convolvul. Jalapæ. E. / Jalapii. L. } gr. 5—12.
Tinctur. Convolvul. Jalapæ. E. dr. 3—6.
Tinctur. Jalapii. L. T. Jalapæ. D. dr. 2—4.
Conv. Scammonium. E.
Scammonium. L. D.
Asia. Resin. Pulv. Bol. Pil. gr. 5—15.
Pulvis Scammon. comp. L. gr. 8—15.
E. gr. 10—30.
cum Aloe. L. gr. 5—12.
Electuar. Scammonii. L. D. gr. 15—30.
Hydrop. Vermes.
Cucumis colocynthis. E.
Colocynthis L. D.
Syria. Fructus medulla. Pil. Bol. gr. 2—5.
Extract. Colocynth. comp. L. gr. 5—15.
Gratiola officinalis. E.
Gratiola. D.
Eur. mer. Herba. Radix. Decoct. Pulv. gr. 15—30.
Helleborus niger. E. D.
Melampodium.
Eur. mer. Rad. Pulv. Pil.
Extract. Hellebor. nigri. E. gr. 3—6.
Hydrop.
Helleb. fœtidus.
Helleboraster. L.
Brit. Rad. Fol. Decoct.
Iris Pseudacorus.
Iris. D.
Brit. Rad. recens. Succ. express. gtt. 60—80.
Hydrop.
Linum catharticum. D.
Brit. Herba. Infus. Pulv. dr. 1.
Momordica Elaterium. E.
Cucumis agrestis. L.
Brit. Fructus recens.
Succ. spiss. Momordic. Elater. E. / Elaterium. L. } gr. 1—3.
Hydrop.
Rhamnus Catharticus. E.
Spina cervina. L.
Brit. Bacca. Succ. express.
Syrupus Rhamni cathart. E. / spinæ cervinæ. L. } dr. 6—12.

Hydrop.
Rheum palmatum. E.
Rhabarbarum. L. D.
Russia. Ind. Rad. Pulv. Bol. Pil. gr. 10—40.
Infusum Rhei palmati. E. unc. 1—3.
Vinum Rhei palmati. E. dr. 2—6.
Vinum Rhabarbari. L. unc. 1—2.
Tinctura Rhei palmat. E. / Rhabarbari. L. } unc. $\frac{1}{2}$—1$\frac{1}{2}$.
Rhabarbari comp. L. unc. 1.
Rhei et Aloes. E. dr. 4—6.
Gentian. E. dr. 4—6.
Febres. Dysenter. Dyspeps. Hypochond. Icterum.
Ricinus communis. E. L. D.
Ind. Occ. Seminum Ol. express. dr. 3—unc. 1.
Stalagmitis Gambogioides. E.
Gambogia. L. D.
Ind. Gum-resin. Phil. g. 3—15.

SECT. III. FOSSILIA.

Sulphuretum Antimonii.
Tartris Antimonii. gr. $\frac{1}{4}$ 4ta. quaq. hor.
Dysenter.
Hydrargyrum.
Submurias Hydrargyri. gr. 1—4.
Submurias Hydrargyri præcipitat. E. / Hydrargyr. muriat. mitis. L. / Hydrarg. mur. mit. præcip. D. / Pilulæ Hydrargyri. E. D. L. } gr. 3—10.
Phlegmas. Comata. Colicam. Icterum. Obstipat. &c.
Nitras Potassæ.
Sulphas Potassæ. E. / Kali vitriolatum. L. / Alkali vegetabile vitriolat. D. } dr. 1—12.
Murias Sodæ. E.
Natron muriatum. L.
Alkali fossile muriatum. D.
Brit. Solut. unc. $\frac{1}{2}$—1. Enem.
Sulphas Sodæ. E. / Natron vitriolatum. L. / Alkali fossile vitriolat. D. } unc. 1—2.
Sulphas Magnesiæ. E.
Magnesia vitriolat. L. D.
Brit. Solut. Enem. unc. $\frac{1}{2}$—1$\frac{1}{2}$.
Dysenter. &c.

CLASS VI. EMMENAGOGA.

SECT. I. ANIMALIA.

Murias Ammoniæ.
Carbonas Ammoniæ.
Castor Fiber. E.
Castor. L. D.

Russia Amer. Mater. prope anum collecta.
Pulv. Pil. gr. 10—20. Enem. scr. 2—dr. 1.
Tinctura Castor. L. E. D. gtt. 20 dr. 1.
compos. E. gtt. 20.—dr. 1

SECT. II. VEGETABILIA.

Anthemis nobilis. Pulv. Infus. fort.
Extract. Anthem. nobil. E. } gr. 15—30.
Chamæmel. L. D }
Ammoniacum. Pil. gr. 10.—scr. 1.
Ferula Asa fœtida. Pil. gr. 10—20.
Pil. Asæ fœtid. comp. E. gr. 15—30.
Tinctur. Asæ fœtid. L. E. D. dr. 1—2.
Alcohol. Ammoniat. fœtid. E.
Spir. Ammoniæ fœtid. L. } gtt. 30
Alkal. volatil. fœtid. D. } —dr. 1.
Marrubium vulgare. Infus.
Myrrha.
Pulvis Myrrh. comp. L. gr. 15—20.
Solanum Dulcamara.
Aloe perfoliata. Pil. gr. 1. ter in die.
Pulv. Aloes cum Myrrh. L. gr. 15—30.
Pil. Aloes cum Myrrh. L. gr. 8—15.
E. gr. 5—12.
cum Asa fœtida. E. gr. 10. bis in die.
Tinctura Aloes compos. L. unc. 1.
cum Myrrha. dr. 2—4.
Bryonia alba. Pulv. gr. 10—20.
Helleborus niger.
Tinctura Hellebor. nigr. E. dr. 1. bis in die.
Rheum palmatum. Pulv. gr. 5—10. bis in die.
Pilul. Rhei compos. scr. 1.—dr. ½.
Arnica montana. E. L.
German. Flores. Infus. scr. 1—2. in die.
Bubon Galbanum. E.
Galbanum. L. D.
Afric. Gum-resin. gr. 10—20.
Tinctura Galbani. L. dr. 1.
Pilul. Galbani compos. gr. 15—30.
Juniperus Sabina. E.
Sabina. L. D.
Asia. Fol. Pulv. gr. 10—15. bis in die.
Extract. Sabinæ compos. L. D. gr. 5—10. bis in die.
Tinct. Sabinæ. L. gtt. 40 -60.
Pastinaca Opopanax. E.
Opopanax. L. D.
Eur. mer. Gum-resin. Pil.
Rosmarinus officinalis. E.
Rosmarinus. L. D.
Eur. mer. Summitat. Infus.
Rubia tinctorum. E.
Rubia. L. D.
Brit. Zealand. Rad. Pulv. dr. ½—1. ter in die.
Ruta graveolens.
Ruta. L. D.
Eur. mer. Herba. Infus.
Extract. Rutæ. L. D.
Sagapenum L. E. D.
Ægypt. Gum-resin. Pil.

SECT. III. FOSSILIA.

Hydrargyrum.
Submurias. Hydrargyri. gr. 3—5.
præcip. gr. 5—10.
Pilulæ Hydrargyr. gr. 10—20.
Ferrum. E. L. D.
Brit., &c.
* Carbonas Ferri. E. } scr. 1—dr. 1.
Rubigo Ferri. L. D. } bis in die.
Carbonas Ferri præcip. E. gr. 5—15.
Aqua Ferri Ærati. D. lib. ½.—1. in die.
Sulphas Ferri. E. } gr 1—5. bis
Ferrum vitriolat. L. D. } in die.
Vinum Ferri. L. dr. 2—4.
Tinctur. Muriatis Ferri. E. } gtt. 10—20. bis terve in die.
Ferri muriat. L. D. }

* The quantity of Carbonic Acid in these two preparations, can scarcely entitle them to the name of Carbonate; they are rather Carbonated Oxyde, or what Dr. Thomson calls Oxy-carbonates.

CLASS VII. ERRHINA.

SECT. I. VEGETABILIA.

Asarum europæum. Pulv.
Pulvis Asari europ. compos. E.
Asari compos. L.
Nicotiana tabacum. Pulv.
Rosmarinus Officinalis. Pulv.
Iris florentina.
Iris. L.
Ital. Rad. Pulv.
Lavandula spica. E.
Lavandula. L. D.
Eur. mer. Flores. Pulv.
Origanum majorana. E.
Majorana. L. D.
Eur. mer. Folia. Pulv.
Teucrium marum.
Marum syriacum. L.
Eur. mer. Herba. Pulv.
Veratrum album. E.
Helleborus albus. L. D.
Eur. mer. Rad. Pulv.

SECT. II. FOSSILIA.

Hydrargyrum.

Subsulphas Hydrarg. flav. E. } gr. 1. bis
Hydrargyr. vitriolat. L. D. } in die.

CLASS VIII. SIALAGOGA.

SECT. I. VEGETABILIA.

Daphne Mezereum. Rad. masticat.
Odontalg. Paralys.
Amomum Zingiber. L. E.
Zingiber. L. D.
Ind. Occ. Rad. masticat. Infus.
Odontalg.
Anthemis Pyrethrum. E.
Pyrethrum. L. D.
Eur. mer. Rad. masticat. Infus.
Pistacia lentiscus. E.
Mastacia. L. D.
Eur. merid. Resina. Masticat.

SECT. II. FOSSILIA.

Hydrargyrum.
Hydrargyrum purificatum.
Submurias Hydrargyri. gr. 1—2. bis in die.
Murias Hydrargyri. g. $\frac{1}{8}$—$\frac{1}{4}$. bis terve in die.
Submurias Hydrarg. præcip. gr. 2. bis in die.
Pilulæ Hydrargyri. gr. 6—8. bis in die.
Oxidum Hydrargyri cinereum. E. } gr. 2. bis in die.
Pulvis Hydrargyri cinereus. D. }
Unguentum Hydrargyr. E. scr. 4. } alternis vel singulis noctibus.
fortius L. D. scr. 2.
mitius. L. D.
Hydrargyr. calcinatum. L. gr. $\frac{1}{2}$. bis in die.
Acetis Hydrargyria. E. } gr. 2.
Hydrargyr. acetatum. L. D. }
Hydrargyrus sulphurat. ruber. L. externe.
Sulphuretum Hydrargyri nigrum.
Hydrargyr. cum Sulphure. L.
Hydrargyr. sulphuratus niger. D.
Ad Febrem flav. Phrenit. Hydrocephalic. Ophthalm.
Cynanch. tracheal. Hepatit. Chronic. Comata. Tetanum.
Hydrophob. Hydrop. Chloros. Siphilid. Lepr. Icterum. Psoram, Vermes.

CLASS IX. EMOLLIENTIA.

SECT. I. ANIMALIA.

Acipenser Huso. Sturio., &c. E.
Ichthyocolla. L. D.
Russia. Decoct. ad libit.
Ovis Aries. E.
Ovis sevum. L.
Sevum ovillum. D.
Brit. Ungt. Liniment. Cerat.
Physeter macrocephalus. E.
Sperma Ceti. L. D.
Sevum. Unguent., &c.
Sus scrofa. E.
Adeps suillum. L. D.
Brit., &c. Adeps. Unguent., &c.
Linimentum simplex. E.
Unguentum Adipis suillæ. L.
simplex. E.
Unguentum spermatis Ceti. L. D.
Ceræ. L. D.
Ceratum simplex. E.
Spermatis Ceti. L. D.
Cera alba. et flava. E. L. D.
Brit. Emuls. Unguent., &c.
Ad Diarrhœam. Dysenter. Ulcera.

SECT. II. VEGETABILIA.

Olea europæa. Liniment., &c. et interne.
Althea officinalis. E.
Althea. L. D.
Brit. Rad. Decoct. ad libit.
Decoct. Altheæ officinal. E. ad libit.
Syrupus Altheæ. E. L.
Amygdalus communis. E.
Amygdal. dulc. et amar. L. D.
Eur. mer. Fructus nucl. et Ol. express.
Emulsio Amygdali communis. E. } ad libit.
Lac Amygdalæ. L. D. }
Ad Febres. Pneumon. Catarrh., &c.
Oleum Amygdali communis.
Astragalus Tragacantha. E.
Gum Tragacantha. L. D.
Eur. mer. Gummi. Pulv. Solut. ad libit.
Mucilago Astragali Tragacanthæ. E.
Mucilag. Tragacanthæ. L.
Mucilag. Gum. Tragacanthæ. D.
Pulvis Tragacanthæ comp. L. dr. 1—4.
Avena sativa. E.
Avena. L. D.
Cult. Semen. Decoct. ad libit.
Febres. Pneumon. Catarrh. Dysenter. Diarrhoea., &c.
Cocos Butyracea. E.
Amer. merid. Oleum nucis fixum.
Externe.
Eryngium maritimum. E.
Eryngium. L. D.
Brit. Rad. recens.
Glycyrrhiza glabra. E.
Glycyrrhiza. L. D.
Eur. mer. Rad. Pulv. Decoct. Succ. spissat.

Trochisci Glycyrrhiz. E. L. D. ad libit. Catarrh., &c.
Hordeum distichon. E.
Hordeum. L. D.
Cult. Semen. Decoct. ad libit.
Ut Avena.
Decoctum Hordei distichi. E. } ad libit.
compositum. L.
Lilium candidum.
Lilium album. D.
Cult. Rad. recens. Catapl.
Linum usitatissimum. E.
Linum. L.
Cult. Semen. Infus. Ol. express.
Oleum Lini usitatiss. E. unc. 1—3.
Lini. L. D.
Pneumon. Nephrit. Dysenter. Hæmopt.
Malva sylvestris. E.
Malva. L. D.
Brit. Folia. Decoct.
Decoctum pro Enemate. L.
Melissa officinalis. E.
Melissa. L. D.
Cult. Herba. Infus.
Mimosa nilotica. E.
Gummi Arabicum. L. D.
Arab. Senegal. Gum. Pulv. Solut. ad libit.
Mucilago Mimosæ niloticæ. E. } ad libit.
Arabici Gummi. L. D.
Emulsio Mimos. nilot. E.
Arabica. L. D.
Trochisci Gummosi. E.
Catarrh. Pneumon. Diarrh. Blenorrh.
Pyrus Cydonia. E.
Cydonia Malus. L.
Cult. Semen.
Mucilago Seminis Cydoniæ mali. L.
Sarcocolla.
Asia succ. spissat.
Triticum hibernum. E.
Amylum. L.
Cult. Semen.
Mucilago Amyli. E. D. } ad libit.
Trochisci Amyli. L.
Vitis vinifera. E.
Vitis. L. D.
Fruct. sicc. Uvæ passæ.
Decoct. ad libit.

CLASS X. REFRIGERANTIA.

SECT. I. VEGETABILIA.

Acidum Acetosum dilutem ad libit. extern.
Acetis Potassæ. dr. 2. ad aq. lib. 1 in die.
Aque Acetitis Ammoniæ, unc. ½ freq.
Febres. Phlegmas.
Supertartris Potassæ solut. ad libit.
Tamarindus Indica.
Fructus ad libit.
Febres.
Berberis vulgaris.
Berberis. D.
Brit. Fructus.
Febres.
Citrus medica. E.
Limonium. L. D.
Eur. mer. et Ind. Occ. Fruct. succ. rec. et crystall.
Syrup. Citri. medic.
Limonii. L. D.
Febres.
Citr. Aurantium. E.
Aurantia. L. D.
Eur. mer. Fruc. succ. recens.
Cochlearia officinalis. E.
Cochlearia. D. C. hortens. L.
Brit. Herba. et succus.
Succ. Cochlear. comp. E. L. ad libit.
Ad Scorbutum.
Morus nigra.
Morus. L.
Cult. Fructus.
Syrupus Fruct. Mori. L.
Oxalis Acetosella.
Lijula. L.
Acetosella. D.
Brit. Herba. Succ.
Conserv. Acetosellæ. D.
Lijulæ. L.
Ribes nigrum. L. D.
Brit. Fruct.
Succ. spissat. Rib. nigr. L.
Syrup. succ. Rib. nigr. L.
Ribes rubrum. L. D.
Brit. Fructus.
Rosa canina. E.
Cynosbatus. L.
Brit. Fruct.
Conserva Rosæ caninæ. E.
Cynosbati. L.
Rubus Idæus. L. D.
Brit. Fructus.
Syrup. Fruct. Rub. Idæi. L. D.
Rumex Acetosa. E.
Acetosa. D.
Acet. pratensis. L.
Brit. Folia.
Sisymbrium Nasturtium. E.
Nasturt. aquatic. L. D.
Brit. Herba.
Ad Scorbutum.
Veronica. Beccabunga.
Beccabunga. L.
Brit. Herba.
Ad Scorbutum.

SECT. II. FOSSILIA.

Zincum.
Sulphas Zinci. Externe pro Lotione.
Nitras Potassæ.
Acid. nitrosum. dr. 1—2. ad Aq. lib. 1. in die.
Febres, &c.
Spirit. ætheris nitrosi. L. E. } gtt. 30—
æthereus nitros. D. } dr. 1.
Trochisci Nitrat. Potass. E.
Nitri. L.
Febres. Phlegmas. Hæmorrh. Maniam.
Murias Sodæ.
Acidum Muriaticum. gtt. 20—40 dilut. subind.
Febres.
Acidum Sulphuricum. E.
Vitriolicum. L. D.
Acidum Sulphuric. dilutum. E. } ut Ac.
vitriolic. dilut. L. D. } Mur.
Febres. Hæmorrhag.
Plumbum. E. L. D.
Acetis Plumbi. E.*
Cerussa Acetata. L. D.
Interne ad Hæmorrhag. sed cautissime.
Aqua Lithargyr. acetati. L. } Externe.
Liquor Litharg. acetat. D. }
Aqua Lithargyr. acetat. comp. L.
Liquor Litharg. Acetat. comp. D.
Unguent. Acetit. Plumb. E.
Ceruss. acetat. L.
Cerat. Litharg. acetat. comp.
Ad Phlegmasias. &c.

* It is now found that there are two acetates of lead, an acetate which crystallizes in scales, and this salt, which, containing an excess of acetic acid, should be called superacetas plumbi.

CLASS XI. ASTRINGENTIA.

SECT. I. VEGETABILIA.

Hæmatoxylum campechian. E.
Hæmatoxylum. L. D.
Americ. Lign. Decoct.
Extract. Lign. Hæmat. }
camp. E. } gr. 10—30.
Hæmatoxyl. L. D. }
Juglans regia.
Juglans. L.
Brit. Fruct. immatur. Decoct. Externe. Ulcera.
Kino. E. L. D.
Africa Pulv. Solut. gr. 15—30.
Tinct. Kino. E. D. dr. 1—2.
Diarrh. Dysent. Menorrh.
Mimosa Catechu. E.
Catechu. L. D.
India. Extract. lign. Pulv. Solut. scr. 1—2.
Infus. Mimos. Catechu. E. unc. ½—1½.
Tinct. Mimos. Catechu. E. } dr. 1—3.
Catechu. L. }
Elect. Catechu. E. } scr. 3—4.
Comp. D. }
Diarrh. Dysenter.
Anchusa. Tinctoria. E.
Anchusa. D.
Eur. Merid. Radix.
Boletus igniarius. E.
Agaricus.
Brit. ad vulnera.
Pterocarpus Santolinum. E.
Santolinum rubrum. L. D.
India Lign.
Polygonum Bistorta.
Bistorta. L. D.
Brit. Rad. Pulv. dr. ½—1. Decoct.
Potentilla reptans.
Pentaphyllum. L.
Brit. Fol.
Prunus Spinosa.
Prun. sylvestris. L.
Brit. Fruct. ad libit.
Conserv. Prun. sylvestris. L. dr. 1—3. Diarrh.
Pterocarpus Draco. E.
Sanguis Draconis. L. D.
Amer. merid. Resina.
Punica granatum.
Granatum. L.
Flor. Balaust. D.
Eur. Merid. Flor. Cort. Fruct.
Decoct. ad Gargar. ad libit.
Quercus cerris. E.
Gallæ. L. D.
Asia. Cyniphis nidus. Pulv. Inf. Ungt.
Quercus robur. E.
Quercus. L. D.
Brit. Cort. Decoct. Externe.
Scarlatin. Angin.—Uvulæ relaxat. Hæmorrh. Menorrhag.
Rosa Gallica. E.
Ros. Rubr. L. D.
Eur. Merid. Brit. Petal. Inf. Conserv. ad libit.
Inf. Ros. Gallic. E. }
Rosæ. L. } ad libit.
Rosar. D. }
Conserv. Ros. gallica. E.
Rosæ. D.
Ros. rubr. L.
Syrup. Ros. Gall. E.
Mel. Ros. L. D.
Hæmorrh. Cynanchen, &c.
Tormentilla erecta. E.
Tormentilla. L. D.
Brit. Rad. Decoct. unc. ½—1.
Diarrhœa.

SECT. II. FOSSILIA.

Sulphas Cupri. gr. ½—1. bis terve in die.
Febr. Intermitt.
Inject. Lot. Collyr.
Solut. Sulphat. Cupri. E.
Liquor Cupri Ammoniat. D.
Aq. Cupri. Ammon. L.
Ophthalm. Gonorrhœa.
Zincum.
Sulphas Zinci. gr. 2—5. bis terve in die.
Febres Intermitt.
Solutio Acetit. Zinci. Collyr. Inject.
Aqua Zinciæ Vitriolat. cum Camphora. L.
Ophthalm. Blenorrh.
Ferrum.
Tinctura Muriat. Ferri. gtt. 10—20. ter in die.
Menorrhag. cum debilitate.
Plumbum.
Acetis Plumbi. Lotion.
Oxydum album et Semivitreum.
Super-Sulphas Alumin. et Potass.
Sulphas Alumin. E.
Alumen. L. D.
Brit. Pulv. Solut. gr. 5—15.
Externe p. Gargar. et Lotione.
Sulphas Alumin. exsiccat. E.
Alumen ustum. L.
Pulvis Sulphat. Alumin. comp. E. gr. 15—30.
Cataplasm. Aluminis. L.
Ophthalm.
Aqua Alumin. Comp. L. pro Lotione.

CLASS XII. TONICA.

SECT. I. VEGETABILIA.

Anthemis Nobilis. Pulv. gr. 10—scr. 1. Infus. unc. ½. ad lib. 1.
Centaunæ benedicta. Infus.
Marrubium Vulgare. Infus.
Myrrha. Pulv. Pil. gr. 10—20.
Pulv. Myrrh. Comp. gr. 20. ad 30.
Dorstenia Contrajerva. Pulv.
Pulv. Contrajerv. Comp. L. gr. 20—30.
Vitis Vinifera.
Vinum rubrum Lusitanum.
Æsculus Hippocastanum. E.
Asia. Brit. Cort. Pulv. dr. ½—scr. 2.
Decoct. unc. 1. ad lib. 1.
Angustura. E. L. D.
Ind. Occident. Cort. Pulv. gr. 15—dr. ½. Inf.
Chironea. Centaur. Gentian. Cent. E.
Centaur. Min. D.
Brit. Summitat. Infus.
Cinchona officinalis. E.
Cinchona. L.
Cort. Peruv. D.
Peru. Cort. Pulv. dr. ½—2. Electuar. Enem. dr. 1—3.
Inf. Cinchon. Off. E. / Cort. Peruv. } unc. 2—4
Decoct. Cinchon. Off. / Cort. Peruv. } unc. 3—6
Tinct. Cinchon. Off. E. L. D. unc. ½—1.
Comp. L. D. dr. 3—6.
Ammoniat. dr. ½—1.
Extract Cinchon. Off. E. / Cort. Peruv. L. D. } gr. 10—20.
Ad Febres. Rheumatism. Odontalg. Catarrh. Febril. Blenorrh. Dysenter. Erysipelat. Scarlatin. Hæmoptys. Menorrhag. Dyspeps. Hypochond. Astheniam. Spasmos. Hydrop.
Cinchona Carribbæ.
Insul. Carribb. Cort. (ut Cinchon. Off.)
Columba. L. E. D.
Ceylon. Africa. Rad. Pulv. gr. 5—20.
Inf. dr. 3. ad lib. 1.
Tinct. Columbæ. L. D. E.
Croton Eleutheria. E.
Cascarilla. L. D.
Ind. Or. et Occident. Cort. Pulv. scr. 1—dr. 1.
Tinct. Cascarill. L. D. dr. 2—6.
Extract Cascarill. L. D. gr. 10—20.
Gentiana lutæ. E.
Gentiana. L. D.
Eur. Merid. Rad.
Inf. Gentian. Comp. E. unc. ½—1.
D. dr. 6—12.
L. unc. 2—4.
Tinct. Gentian. Comp. E. L. dr. 2—6.
Vin. Gent. Comp. E. unc. 1—2.
Extract. Gent. L. D. lut. E. gr. 10—30.
Menyanthes Trifoliata. E.
Trifol. Paludos. L.
Brit. Rad. Exsiccat. Inf. unc. ½—lib. 1.
Quassia Excelsa. E.
Quassia. L.
Insul. Caribb. Lignum. Cort. Rad. Inf. dr. ½—2. ad. lib. 1.
Qu. Simaruba. E.
Simarouba. L. D.
Ind. Occ. Cortex. Decoct. dr. 2. ad lib. 1.
Salix fragilis.
Salix. D.
Brit. Cortex. Pulv. scr. 2—4.
Decoct. unc. 2. ad lib.
Swietenia Mahagani. E.
Ind. Occ. Cortex. Pulv. Decoct. ut Cinchona.
Sw. Febrifuga. E.
Ind. Occ. Cort. ut supra.
Tanacetum. vulgare.
Tanacetum. L. D.
Brit. Fol. Flor. Infus.
Ad Vermes.

SECT. II. FOSSILIA.

Sulphas Cupri. gr. 1—3. bis terve in die.
Febr. Intermitt.
Ammoniaretum Cupri. E. } gr. $\frac{1}{2}$
Cuprum Ammoniatum. L. } gr. $\frac{1}{2}$
bis terve in die.
Pilulæ Ammoniar. Cupri. E. Pil. 1.
Epileps.
Zincum.
Sulphas. Zinci. gr. 2—5. bis terve in die.
Febr. Intermitt. Epileps.
Solutio Sulphat. Zinc. E.
Externe pro Collyrio.
Oxydum Zinci. E.
Zincum calcinatum. L. } gr. 1. bis terve in die.
Calx Zinci. D. } gr. 1. bis terve in die.
Epileps.
Nitras Potassæ.
Acidum Nitrosum. gtt. 30—40.
Sulphas Magnesiæ. Solut. dr. 2. bis in die.
Ferrum.
Carbonas Ferri scr. 1—dr. 1.
Præcip. gr. 5—15.
Aq. Ferri ærati. D. lib. $\frac{1}{2}$. bis in die.
Sulphas Ferri. gr. 1—5.
Vinum Ferri. dr. 2—6. bis in die.
Tinct. Muriat. Ferri. gt. 10—30. bis in die.
Sulphas Ferri exsiccat. E.
Oxydum Ferri rubrum. E.
Emplast. Occid. Ferri rub. E.
Ferri limatura purific. E.
Oxydum Ferri nigr. purific. E.
Murias Ammon. et Ferri. E. } gr. 3—10.
Ferrum Ammoniacale L. } gr. 3—10.
Tinct. Ferr. Ammoniac. L. gtt. 10—30.
Tartris Ferri et Potassæ. E. } gr. 10—30.
Ferrum Tartarisatum. L. } gr. 10—30.
Tinct. Ferri acetati. D. gtt. 20—40.
Dyspeps. Hypochondrias. Asthen. Chorcam. Hydrop. Chloros. Phthis. Vermes.
Acidum Sulphuricum.
Acidum Sulphur. dilutum. gtt. 20-40.
Acidum Sulphuric. Aromaticum E. gtt. 10—20. bis terve in die.
Dyspeps, &c.
Argentum. L. E. D.
Nitras Argenti. E. } gr. $\frac{1}{8}$—$\frac{1}{4}$. bis in die.
Argentum Nitratum. L. D. } gr. $\frac{1}{8}$—$\frac{1}{4}$. bis in die.
Arsenicum. Oxid. alb. vel. Acid. Arsen.
Oxidum Arsenici. E.
Solut.
Carbonas Barytæ. E.
Vid. Sulphas Barytæ.
Carbonas Calcis. E.
Creta. L. D.
Brit. &c.
Solutio Muriatis Calcis. E. gt. 30—60. bis terve in die.
Ad Scrofulam, Schirrum, &c.
Sulphas Barytæ.
Terra ponderosa.
Brit.
Murias Barytæ. E.
Solutio Muriatis Barytæ. E. gt. 5—10. bis terve in die.
Ad Scrofulam, Schirrum, &c.

CLASS XIII. STIMULANTIA.

SECT. I. ANIMALIA.

Murias Ammoniæ.
Aqua Ammoniæ. E. gt. 10—20.
pur. L.
Liquor. alkal. volat. caust. D.
Alcohol Ammoniatum. E. gt. 20—40.
Spiritus Ammoniæ. L.
Alkal. volat. D.
Carbonas Ammoniæ. E. gr. 5—10.
Ammonia præparata. L.
Alkali volatile mite. D.
Aqua Carbonat. Ammon. E. gt. 20—dr. 1.
Ammoniæ. L.
Liq. alkal. volatil. mit. D.
Liq. volat. Cornu Cervi, L. gt. 20—dr. 1.
Sal. Cornu Cervi, L. gr. 10—20.
Oleum Ammoniatum, E.
Liniment. Ammon. fort. L.
Liniment. Ammon. L.
Liniment. volatile. D.
Alcohol. Ammoniat. aromaticum. E. gt. 20—dr. 1.
Spir. Ammon. comp. L.
Alcoh. volat. arom. D.
Spir. Ammon. succin. L.
Asphyx. Spasmos. Rheumatism, &c.
Moschus moschiferus.
Bol. Mist. gr. 10—scr. 1.
Mistura Moschata unc. 1—2.
Ad Typhum. Gangraen.
Coccus Cacti. E.
Coccinella. L.
Mexico.
Lytta vesicatoria.
Bol. gr. 1—3.
Tinct. Meloes vesicat. gt. 10—30.
Ungt. Infus. mel. vesicat. E.
Cantharid. L D.
Pulv. mel. vesicat. E.
Ceratum. Cantharid L.
Empl. melo. vesicat. E.
Cantharidis L. D.
mel. vesicat. com. E.

Ad Synoch. Typh. Phrenit. Cynanch. Pneumon. Gastrit. Enterit. Rheumatism. Odontalg. Variol. Scarlatin. Apoplex. Paralys. Chorcam. Asthm. Dyspnœam. Pertuss. Colicam. Hysteriam. Hydrophob. Maniam Icterum. Caligin. Amauros. Ischuriam.

SECT. II. VEGETABILIA.

Sinapis alba.
Semen et ejusd. Pulvis. dr. 1—4.
Cataplasma Sinapeos. L. D.
Rheumatism. Paralys.
Allium sativum.
Rad. recens.
Arum maculatum.
Rad. recens. Bol. Elect. Emuls. gr. 10—20. bis in die.
Conserva Ari. L dr. $\frac{1}{2}$—dr. 1.
Rheumatism.
Pimpinella Anisum.
Semen.
Ol. volat. Pimpin. Anisi. gtt. 2—6.
Dyspeps. &c.
Styrax Benzoin.
Balsamum.
Acidum Benzoicum. gr. 1—3.
Tinctura Benzoes comp. L. gtt. 10—20.
Alcohol.
Æther Sulphuricus. dr. $\frac{1}{2}$—dr. 1.
Ad Morb. spasmod.
Æther Sulphuric cum. Alcohole. E.
Spiritus Ætheris vitriolici. L. } gtt. 15—30.
Liquor ætherus. vitriolicus. D. } gtt. 15—30.
ÆtherSulphur. cum Alcohol. comp. E. } gtt. 15—30.
Spir. æther. vitriol. comp. L. } gtt. 15—30.
Oleum Vini. L. gtt. 10—20.
Acidum Acetosum.
Acidum Acetosum forte. E.
Externe per nares in Syncope, Asphyxia, &c.
Acidum Acetosum Camphoratum, E.
Ut supra.
Acetum Aromaticum. E.
Ut supra.
Aristolochia Serpentaria.
Rad. Pulv. Bol. scr. 1—2.
Tinctura Aristol. Serpentar. dr. 2—6.
Typh. Dyspeps.
Daphne Mezereum.
Rad.
Decoctum Daphn. Mezerei. unc. 1—2. sæp. in die.
Ad morbos cutan. Syphil.
Guaiacum officinale.
Lign. Decoct. unct. 1. ad. lib. 1. Resin Pulv. Emuls. gr. 10—20.
Rheumatism Syphil. Morb. cutan.
Decoctum Guaiac. officin. unc. 4—8. bis in die.
Tinctura Guaiac. offic. dr. 2—4.
ammoniat. dr. 1—3.
Papaver somniferum.
Opium. gr. $\frac{1}{4}$—1. dos. repetit.
Tinctura Opii gtt. 5—20. simili modo.
Camphorat. dr. 1—4.
Ammoniat. dr. $\frac{1}{2}$—1.
Typh. Dyspeps, Tetan. &c.
Cochlearia Armoracia.
Rad rec. Subst. Infus.
Spirit Raphani comp. L. unc. 1—2.
Paralys. &c.
Copaifera officinalis.
Balsam. gtt. 15—30.
Pinus { Sylvestris. Larix.
Ol. vol. Pini puriss.
Ungt. Resin. flav. L. D.
Resinosum. E.
Cerat. Resin. flav. L.
Empl. Ceræ. D. comp. L.
Ungt. Picis. L. D.
Empl. Picis. Burgund.
Externe ad Ulcera. &c.
Arnica montana.
Rad. Pulv. scr. 1—2.
Typh. Paralys.
Bubon Galbanum.
Pilul. Galbani comp. gr. 15—20.
Emplastrum Galbani comp. E.
Lithargyri compos. L.
Juniperus Sabina.
Oleum Juniper. Sabinæ, gt. 1—4.
Pastinaca Opoponax.
Pil. gr. 2—5.
Veratrum album.
Unguentum Hellebori albi. L.
Decoct. Hellebori albi. L.
Ad. morb cutan. L.
Amomum Zingiber.
Rad. Pulv. gr. 5—20.
Podagr. retroced. vel atonic. Paralys. Dyspeps, &c.
Syrupus Amom. Zingib.
Tinctura Amom. Zingib. E. dr. 2—4.
Acorus Calamus. E.
Calamus aromaticus. L.
Brit. Rad. Pulv.
Amomum repens. E.
Cardamomum minus. L. D.
India. Semen.
Tinctura Amomi repent. E. | dr. 2—4.
Cardamomi. L. D. | dr. 2—4.
comp. L. dr. 2—4.
Amyris Gileadensis.
Asia. Resina.
Amyris Elemifera.

MATERIA MEDICA.

Elemi. L. D.
Amer. mer. Resina.
Unguentum Elemi. L.
Anethum Fœniculum. E.
Fœniculum. L. D.
Brit. Sem. Decoct. Enem.
Oleum volatil. Fœnicul. dulc. D.
Aqua Fœniculi dulcis. L. unc. 1—3.
Anethum graveolens.
Eur. mer. Semen.
Aqua Anethi. L.
Angelica Archangelica. E.
Angelica. L. D.
Cult. Rad. Semen.
Apium Petroselinum. E.
Petroselinum. L.
Cult. Rad. Semen.
Arbutus Uva Ursi. E.
Uva Ursi. L. D.
Eur. merid. Folia. Pulv. scr. 1—dr. 1. Infus.
Ad Calculum.
Artemisia maritima.
Absinthium maritimum. L.
Brit. Cacumen.
Conserva Absinthii maritimi. L.
Decoctum pro Fomento. L.
Canella alba. E. L. D.
India Occid. Cortex. Pulv.
Carbo Ligni.
Delphinum Staphisagria.
Staphisagria. L. D.
Eur. Mar. Sem. Pulv.
Capsicum annuum.
Piper Indicum. L. D.
Ind. Occ. Capsulæ. Pulv. gr. 2—6. Infus.
Ad Febres Scarlatinam anginosam.
Carum Carvi. E.
Carum. L.
Carvi. D.
Cult. Semen. Decoct.
Oleum Carvi. L. gtt. 1—4.
Spiritus Cari Carvi. E. } unc. ½—2.
Carvi. L. D. }
Dyspeps. Colic.
Cistus Creticus.
Ladanum. L.
Syria. Resina.
Emplastrum Ladani compos. L.
Citrus Aurantium.
Aurantium Hispalense. L. D.
Eur. merid. Flores. Cortex. Fruct. Infus.
Oleum volat. Citri Aurant. E. gtt. 2—6.
Aqua Citri Aurantii. E. unc. 1—3.
Tinctura Aurantii Cort. L. D. unc. ½—1½.
Syrupus Citri Aurantii. E.
Cort. Aurantii. L. D.
Conserva Citri Aurantii. E.
Cort. Aurantii. L. D.
Coriandrum sativum. E.
Coriandrum. L. D.
Eur. merid. Semen. Pulv. Infus.
Crocus. sativus. C.
Crocus. L. D.
Cult. Stigmata. Infus.
Syrupus Croci. L.
Tinctura Croci. E. L. dr. 2—4.
Cuminum Cyminum.
Cuminum. L.
Ægypt. Sicil. Semen. Decoct.
Cataplasma Cumini. L.
Emplastrum Cumini. L.
Curcuma longa.
Curcuma. L.
India Radix. Pulv.
Daucus Carota. E.
Daucus Sylvestris. L.
Brit. Semen. Radix. Cataplasm.
Dianthus Caryophyllus. E.
Caryophyllum rubrum. L. D.
Italia. Petala. Infus.
Syrupus Caryophylli rubri. L.
Eugenia caryophyllata. E.
Caryophyllum aromaticum. L. D.
Insul. Molucc. Floris Germen.
Oleum volat. Caryophylli aromatici. gtt. 1—2.
Odontalg. Colic.
Hypericum perforatum.
Hypericum. L.
Brit. Flos.
Inula Helenium.
Enula campana. L. D.
Brit. Radix.
Juniperus Lycia. E.
Olibanum. L. D.
Asia. Gum-resin. Pilul.
Kaempferia rotunda. E.
Zedoaria. L.
India Rad. Pulv.
Lavandula Spica. E.
Lavendula. L.
Lavandula. D.
Cult. Flores.
Oleum volat. Lavandulæ Spicæ. E.
Lavandulæ. L.
Spiritus Lavandulæ. Spicæ. E.
Lavandulæ. L.
Spiritus Lavandulæ comp. E. }
Tinctura Lavendulæ comp. L. } dr. ½—1.
Laurus Cinnamomum. E.
Cinnamomum. L. D.
Ceylon. Cortex. Pulv. gr. 5—15. Infus.
Ol. volat. Laur. Cinnamom. }
L. essent. Cinnamom. } gt. 1—2.
D. }
Aqua Laur. Cinnam. E. unc. 1—3.
Cinnamom. L. D.
Spir. Laur. Cinnamom. E. unc. ½—1½.
Cinnamom. L. D.

Tinct. Laur. Cinnamom. E. dr. 2—4.
Cinnamom. L. D.
Cinnamom. comp. E. dr. 1—2.
Cinnam. comp. L. D.
Pulv. Aromaticus. L. E. D. gr. 10—20.
Electuar. Aromat. E. D. gr. 10—30.
Confect. Aromat. L.
Laurus Cassia. E.
Cassia lignea. D.
India Cortex. Pulv. &c. Flor. nondum. explicit.
Aqua Lauri Cassiæ. E. unc. 2—4.
Laurus nobilis. E.
Laurus. L. D.
Cult. Folia. Bacc. et Oleum Bacc. Externe.
Lobelia syphilitica. E.
Virgin. Rad. Pulv.
Ad Siphilidem.
Melaleuca Leucodendron. E.
Cajeputa.
Insul. Molucc. Ol. essential. gtt. 1—4. et Externe.
Rheumatism.
Mentha viridis. E.
Mentha sativa. L. D.
Cult. Herba. Infus.
Oleum Menthæ sativæ. L. gtt. 2—6.
Aqua Menthæ sativæ. L. D. unc. 2—6.
Spiritus Menthæ sativæ. L. unc. 1—2.
Colic.
Mentha Piperita. E.
M. Piperitis. L. D.
Cult. Herba. Inf.
Aq. Menthæ piperitæ. E. unc. 1—4.
piperitidis. L. D.
Ol. volat. Menthæ piper. E. gt. 1—3.
essent. M. piperitid. L. D.
Spir. Menthæ piperit. E. dr. 2—6.
piperitid. L. D.
Mentha Pulegium. E.
Pulegium. L. D.
Cult. Herba. Infus.
Aq. Menth. Pulegii. E. unc. 2—4.
Pulegii. L. D.
Ol. volat. Menth. Puleg. E. gt. 1—3.
essent. Pulegii. L. D.
Spirit. Pulegii. L. unc. 1—2.
Myristica Moschata. E.
Myristica. L.
Nux Moschata. D.
Insul. Molucc. Nucleus. Pulv. Ol. volatil. et express. gtt. 1—3.
Spiritus Myristic. Moschat. E. } dr. 2—6.
Nucis moschatæ. L. D. }
Myroxylon Peruiferum. E.
Balsamum Peruvianum. L. D.
Amer. merid. Balsam. gtt. 10—30.
Tinctura Balsami Peruviani. dr. 1—2.
Myrtus Pimenta. E.
Pimento. L. D.
Jamaica. Bacca.

Aq. Myrti Piment. E. unc. 2—6.
Piment. L.
Ol. volat. Myrt. Pim. E. gt. 1—3.
Spir. Myrt. Piment. E. unc. 1—2.
Pimento. L. D.
Origanum vulgare. E.
Origanum L. D.
Brit. Herba.
Oleum Origani. L.
Ad Odontalg.
Panax quinquefolium.
Ginseng. L.
China. Radix. Pulv.
Parietaria officinalis.
Parietaria. L.
Brit. herba.
Pinus balsamea. E.
Balsamum Canadense.
Americ. septent. Resina liquida.
Piper nigrum. E. L. D.
India. Fruct.
Piper Cubeba.
Cubeba. L.
Java. Fruct.
Pip. longum. E. L. D.
Fruct.
Pistacia Terebinthus.
Terebinthina Chio. L.
Insul. Chio. et Cyprus.
Rhus Toxicodendron. E.
Amer. Folia. Pulv. gr. ½.—bis terve in die.
In Paralysin.
Styrax officinale, E.
Styrax. L. D.
Eur. merid. Balsam.
Styrax Purificata. L. D.
Toluifera Balsamum. E.
Balsamum Tolutanum. L. D.
Amer. merid. Balsam. Troch.
Tinctura Toluiferæ Balsam. E.
Syrupus Toluiferæ Balsam. E.
Tolutan. L.
Trigonella Fœnum græcum.
Fænum græcum. L.
Gallia. Semen. Catapl. Fotus.
Urtica dioica.
Urtica. L.
Brit. Herb. rec. externe. Pulv. scr. 1—dr. 1.
Paralys. Febr. Intermitt.
Wintera aromatica. E.
Amer. merid. Cortex. Pulv.

SECT. III. FOSSILIA.

Hydrargyrum.
Vid. Sialogoga.
Ungt. Oxid. Hydr. rubr. E.
Nitrat. Hydrarg. E.
Hydrarg. nitrat. L.
Un. nitrat. Hydrarg. mitius. E.
Nitras Potassæ.

Acidum nitrosum. dr. 1—in die.
Unguentum Acidi nitrosi. E.
Ad morb. cutan.
Sapo Hispanus.
Tinctura Saponis. E.
Linimentum Saponis compos. L.
Saponaceum. D.
Rheumatism, &c.
Tinctura Saponis cum Opio. E.
Ceratum Saponis. L. D.
Emplastrum Saponis. L.
Saponaceum. E. D.
Murias Sodæ
Murias Sodæ exsiccatus. E.
Externe in Asphyx.
Acidum Sulphuricum.
Externe in Ungt. ad morb. cutan. et interne.
Oxidum Arsenici.
Externe in Carcinom.
Bitumen Petroleum. E.
Petroleum. L.
India.
Oleum Petrolei.
Sub-boras Sodæ.
Boras Sodæ. E.
Borax. L. D.
India Pulv. Linctus.
Ad Aphthas.
Sub-acetis Cupri. E.
Ærugo. L. D.
Collyr. Ungt.
Oxymel Æruginis. L.
Unguentum Sub. acetit. Cupri. E.
Calx. E.
Calx viva. L. D.
Linimentum Aquæ Calcis. E.
Ad Tineam Capitis.
Nitras argenti.
Externe pro escharchio.

CLASS XIV. ANTISPASMODICA.

SECT. I. ANIMALIA.

Murias Ammoniæ.
Vid. Stimulantia.
Moschus moschiferus.
Pulv. Bol. scr. 1—dr. ½.
Cervus Elaphus.
Ol. Animal. L. } gtt. 15
Cornu Cervin. rectificat. D. } — 30.
Castor Fiber. Pulv.
Tinctur. Castor. gtt. 30—dr. 1.
compos. gtt. 20—40.
Ad Hysteriam, &c.

SECT. II. VEGETABILIA.

Cephælis Ipecacuanha.
Pulv. gr. 3—6.
Nicotiana Tabacum.
Fum.
Colic.
Ferula Asafœtida.
Pilul. gr. 10—scr. 1.
Alcohol Ammoniat. fœtid. E. }
Spiritus Ammoniæ fœtid. L. } gtt. 15-30
Spt. Alkali. volatil. fœtid. D. }
Pilulæ Asæ fœtid. comp. E.
Emplastr. Asæ fœtid. E.
Hysteria, &c.
Alcohol.
Æther Sulphuricus. dr. ½—2.
Laurus Camphora.
Emulsio Camphorata, unc. 2—3.
Mistura Camphorata, unc. 2—3.
Tinctura Camphoræ. E.
Spirit. Camphoratus, L. D. Externe.
Liniment. Camphor. com. L.
Camphorat. D.
Papaver somniferum.
Opium. Pil. Mist. gr. 1—
Liniment. Enem.
Tinct. Opii.
camphorat. L. dr. 1—4.
ammoniata. E. dr. 1.
Elect. Opiatum. gr. 5.
Pilul. Opii. L.
Opiatæ. gr. 10.
Bubon Galbanum.
Pilul.
Tinctura Galbani. L dr. 1—2.
Pilul. Galbani comp. L. gr. 15—40.
Hysteria.
Vitis vinifera.
Vinum rubrum Lusitanum. lb. 1—in die
Ad Tetanum.
Citrus Aurantium.
Fol. Pulv. dr. ½.
Convuls.
Artemisia Absinthium.
Absinthium vulgare. L.
Brit. Cacumen, Oleum. volat.
Carbonas Potassæ impurus. E.
Cineres clavellati. L. D.
Aqua Potassæ. E.
Kali puri. L.
Lixivium alkali vegetab. caust. D.
Externe in Balneo ad Tetanum.
Cardamine pratensis. E.
Cardamine. L.
Brit. Flores. Pulv. dr. ½. bis in die.
Ad Choream, &c.
Conium maculatum. E.
Cicuta. L. D.
Brit. Folia. Pulv. gr. 1.
Succus spissat. Conii maculat. E.
Extract. Cicutæ. L. D.
Fuligo Ligni Combusti. D.
Hyster.
Hyoscyamus niger. E.
Hyoscyamus. D.
Brit. Folia. Semen.

Succus spissat. Hyoscyam. nigri. E. gr. 2—4.
Valeriana officinalis. E.
Valeriana. L. D.
Brit. Radix. Pulv. scr. 1—dr. 1—bis terve in die.
Tinctura Valerianæ. L. dr. 2—4.
Ammoniat. E. dr. 1.
Extract. Valerian. sylvestr. Resinos. D.
Ad Hysteriam, &c.

SECT. III. FOSSILIA.

Hydrargyrum.
Vid. Sialagoga.
Bitumen Petroleum. E.
Petroleum. L. D.
Italia.
Oleum Petrolei. L.
Succinum. L. E. D.
Oleum Succini. E.
purissimum. E. } gtt. 10
rectificat. L. D. } —20.
Sal Succini. D.
Spiritus Ammoniæ. succinat. L. gtt. 30.

CLASS XV. NARCOTICA.

VEGETABILIA.

Nicotiana Tabacum.
Vinum Nicot. Tabaci. E. gt. 30. dr. 1 bis in die.
Aconitum neomontanum.
Succus spissat. Aconit. napel gr. ½—2.
Papaver somniferum.
Tinct. Opii. gt. 25.
Camphorat. dr. 2—6.
Syrup. Opii. D.
Extr. Papaver. somnifer. E.
Pulv. Opiat. L. E. gr 10.
Elect. Opiatum. E. gr. 43.
Confect. Opiata. L. gr. 36.
Pil. Opii. E. gr. 5.
Opiatæ. E. gr. 10.
Ad Febr. intermittent. Typh. Rheumatism. Odontalg. Catarrh. Dysenter. Ophthalm. Enterit. Scarlatin. Variol. Rubeol. Hæmoptys. Menorrhag. Hæmorrh. Tetan. Choream. Epileps. Pertuss. Asthmat. Hydrophob. Angin. pectoris. Hysteriam. Phthis. Icter. Diabet.
Rhododendron Chrysanthum.
Folia. Vid. Diaphoretica.
Digitalis purpurea.
Pulv. gr. 1.
Tinctura Digital. purpur. gtt. 10—
Ad Synocham. Phrenit. idiopath et Hydrocephalic. Pneumon. Phthisin, &c.
Arnica montana.
Flores. Pulv. gr. 5.
Paralys. Convuls. Amauros.
Rhus Toxicodendron.
Folea. Vid. Stimulantia.
Conium maculatum.
Pil. Pulv. gr. 1.
Succus spissat. Conii maculat. gr. 2.
Hyoscyamus niger.
Succus spissat. Hyoscyam. nigr. gr. 2—4.
Tinctura Hyoscyami nig. E. dr. 1.
Atropa Belladonna. L. D.
Belladonna. L. D.
Brit. Fol. Pulv. gr. 1.
Datura Stramonium. E.
Brit. Fol. Pulv. gr. 1.
Humulus Lupulus*.
Cult. Conus. Pulv. Pil. gr. 3.
Lactuca viroso. E.
Brit. Folia. Succ. spissat. gr. 1.
Ad Hydrop.
Papaver Rhœas. E.
Papaver erraticum. L.
Brit. Petala. Infus.
Syrupus Papaver. errat. L.
Sium nodiflorum.
Sium. L.
Brit. Herba.

CLASS XVI. ANTHELMINTICA.

SECT. I. ANIMALIA.

Murias Ammoniæ.
Aqua Carbonatis Ammoniæ.
Emuls.

SECT. II. VEGETABILIA.

Anthemis nobilis.
Pulv. scr. 1.—dr. ½—bis in die.
Lumbric.

* We have inserted the hop among the articles of the materia medica, as it probably would have been received by the Edinburgh College, had their Pharmacopeia been published some months later. Within the last year it has been frequently employed in the Edinburgh Infirmary as a substitute for opium with great success, as it was found to produce sleep in cases where opium was ineffectual or inadmissible. It is usually administered in the form of a saturated tincture. Vid. De Roches' "Dissert. Inaug. de Humulo Lupulo. Edin. 1803."

Dr. Spens has adopted it in his edition of the Infirmary Pharmacopoeia, and has given a formula of it under the title of "Pilulæ Humuli lupuli."

Nicotiana Tabacum.
Enema.
Ascarid.
Olea Europea.
Oleum. Enema. Emuls.
Allium sativum.
Rad. recens. Subst. ad libitum.
Ferula Asafœtida.
Gum. Resin. Enema. scr. 1—2.
Convolvulus Jalapa.
Rad. Pulv. gr. 10—30.
Convolvulus Scammonium.
Pulv.
Pulvis Scammonii compositus.
Helleborus fœtidus.
Fol. Succ. express.
Lumbric.
Rheum palmatum.
Pulv. gr. 5—10. omni nocte.
Ricinus communis.
Oleum express. unc. ½—1. Enem. unc. 1—2.
Stalagmitis Cambogioides.
Pil. gr. 5—15.
Ad Tæniam.
Ruta graveolens.
Infus. Enema.
Oleum volat. Rutæ. gtt. 3—6.
Juglans regia.
Cortex Fructus immatur. Extract.
Tanacetum vulgare.
Flor. Pulv. scr. 1—2.
Valeriana officinalis.
Rad. Pulv. dr. 1.
Artemisia Santonica. E.
Santonicum. L. D.
Asia. Semen. Pulv. dr. ½.—scr. 2. bis in die.
Dolichos pruriens. E.
Ind. Occ. Pubes leguminum. Elect. gr. 10—30.
Geoffrœa inermis. E.
Jamaica. Cortex. Decoct. Syrup.
Decoctum Geoffr. inerm. E. unc. 1—2. omni mane.
Polypodium Filix mas. E.
Filix. L.
Filix mas. D.
Brit. Rad. Pulv. dr. 2—3.
Ad Tæniam.
Spigelia marilandica. E.
Amer. Rad. Pulv. gr. 10—scr. 2.

SECT. III. FOSSILIA.

Hydrargyrum.
Amalgama Stanni.
Submurias Hydrargyri. gr. 3—10.
Murias Sodæ.
Pulv. dr. ½—unc. 1.
Ferrum.
Carbonas Ferri gr. 10—30.
Sulphas Ferri gr. 3—10.
Ferri limatura purificat. dr. ½—1.
Tartris Ferri et Potassæ gr. 10-scr. 1.
Calx. E.
Calx viva. L.
Calx recens usta. D.
Aqua Calcis. L. E. D. Enema. lib. ½-1.
Ad Ascard.
Stannum, L. E. D.
Stanni Pulvis. E. unc. ½—1.
Ad Tæniam, et Lumbric.

CLASS XVII. ABSORBENTIA.

SECT. I. ANIMALIA.

Cerous Elaphus.
Phosphas Calcis. E. } gr. 10—20 bis in die.
Cornu Cervi ushem ppt. L. } gr. 10—20 bis in die.
Ad Rachit.
Cancer Astagus et Pagurus. E.
Cancris oculi, vel Chelæ. L.
Brit. Lapil. et Chelæ. Pulv.
Chelæ. Cancr. ppt. L. dr. ½—1.
Pulv. e Chel. Cancr. Comp. L. scr. 1—2.
Ad Diarrhœam, &c.
Murias Ammoniæ.
Aq. Ammoniæ. gtt. 10—15.
Carbonas Ammoniæ. gr. 5—15.
Aq. Carbonatis Ammon. gtt. 20—40.
Sal. Cornu Cervi. gr. 5—12.
Ad Cardialg, &c.
Isis nobilis. E.
Corallium. L.
Corallium rubrum præpar. L.
Ostrea edulis. E.
Ostreæ Testeæ. L.
Brit. Testæ Pulv.
Testæ Ostr. præpar. L.
Spongia officinalis. E.
Spongia. L.
Spongia usta. L. scr. 1—2.
Ad Scroful.

SECT. II. VEGETABILIA.

Carbonas Potassæ impurus.
Aqua Potassæ.
Potassa. E. Externe.
Kali purum. L.
Alkali vegetabile caust. D.
Potassa cum Calce. E.
Calx cum Kali puro. L.
Causticum mitius. D.
Carbonas Potassæ. E. gr. 10.
Kali præparatum. L.
Alkali vegetabile mite.
Carbonas Potass. puriss. E. gr. 10.
Aqua Carbonat. Potass. gt. 30.

Kali. L.
Lixivium mite. D.
Aqua super-carbonat. Potass. E. unc. 4. sæp. in die.
Liquor Alkal. veget. mitiss. D.
Ad Cardialg. Calculum, &c.

SECT. III. FOSSILIA.

Sulphur sublimatum.
Sulphuretum Potassæ. E. } gr. 10.
Kali sulphuratum. L.
Alkali vegetabile sulphurat. D.
Ad Venena metallica.
Hydrosulphuretum Ammoniæ. E. gtt. 5—10.
Ad Diabeten.
Sulphas Magnesiæ.
Carbonas Magnesiæ. dr. ½.
Magnesia Alba. L. D.
Magnesia. E. scr. 1—dr. 1.
Magnesia Usta. L. D.
Trochisci Magnesiæ. L. ad libit.
Ad Cardialgiam.
Calx.
Aqua Calcis. E. L. D.
Ad Dyspeps.
Bolus Gallicus. L.
Pulv.
Ad Diarrhœam, &c.
Carbonas Calcis. E.
Creta. L. D.
Carbonas Calcis præparat. E. gr. 15—dr. 1.
Creta præparata. L. D.
Pulv. Carbonat. Calc. com. E. gr. 15—30.
Cretæ composit. L.
Trochisc. Carbonat. Cretæ. E. ad libit.
Cretæ. L.
Potio Carbonat. Calcis. unc. 2—3.
Mistura Cretacea. L.
Aqua Æris fixi. D. lib. ½—1 in die.
Ad Cardialgiam. Calculum.
Carbonas Sodæ impurus. E.
Natron. L.
Alkali fossile mite. D.
Carbonas Sodæ. E. } gr. 10—30.
Natron præparatum. L.
Aqua super-carbonatis Sodæ. E. lib. ½—1. in die.
Ad Calculum, &c.
Carbonas Zinci impurus. E.
Lapis Calaminaris. L. D.
Brit. Ung. et Collyr.
Oxydum Zinci impurum. E.
Tutia. L. D.
Brit. Ung. et Collyr.

To render this article the more complete, we shall add a few remarks upon the nature, use, and indications of the respective classes in the preceding system, as they may be inserted with more propriety here than in any other part of this work.

1. *Of Emetics.*

These may be regarded as irritative or evacuant, or both. Of the first we have instances in the sulphuret of antimony, the tartar emetic of popular language, sulphate of zinc, or white vitriol, and the sulphate of copper, or blue vitriol. Of the second we have instances in ipecacuanha and squills; of the third, in tobacco and foxglove.

From the use of emetic medicines the following direct effects are produced. They excite sickness, nausea, and their common attendants. They produce the action of vomiting itself. They occasion sudden and opposite changes in the circulation. They increase the secretion or the discharge of secreted matter from the various glands which prepare fluids to be deposited in the alimentary canal.

The changes induced in the system in consequence of the primary effects of emetics are: the evacuation of the contents of the stomach, and, in some degree, of the upper part of the intestinal tube: free circulation through the stomach, intestines, and glands, whose secreted matters are acted upon: general agitation of the body: a commotion of the nervous system: a particular affection of the surface of the body. The indications which emetic medicines are capable of fulfilling may be derived from the following sources: 1. Their producing agitation of the body, whence they may be employed to restore uniform circulation; to promote diminished lymphatic absorption; to remove obstruction in the sanguiferous system. 2. From their producing evacuation by vomiting, whence they may be used, to discharge noxious matters taken in by the mouth; to discharge morbid accumulations of secreted matters lodged in the stomach; to evacuate serous accumulations. 3. From the affection of the nervous system which they occasion; whence they may be employed, to restore excitement to the nervous system in general, and obviate inordinate affections of the nervous energy. These indications may be illustrated and confirmed by attention to the use of emetics, when employed in cases of fever, dysentery, pulmonary consumption, jaundice, apoplexy, dropsy, and poisons.

In the use of emetics we ought to pay attention to the circumstances of infancy, old age, pregnancy, delicacy of habit, and plethora. The circumstances chiefly to be regarded with respect to the regimen necessary for this class, are, the state of the stomach when the emetic is exhibited; the means of facilitating the operation; the time of exhibiting the medicine; the temperature in which the patient is kept, after its operation is finished. The different individuals belonging to the class of emetics are chiefly contraindicated by the presence of the following morbid states: a rupture or relaxation of containing membranes; topical inflammation of the internal viscera; a high degree of morbid debility in these; fixed obstructions to the circulation.

2. *Of Expectorants.*

The direct effects of the medicines which are employed under this name are as follow: they stimulate the lungs themselves; they augment the secretion taking place by the mucous glands of the lungs; they increase the excretion of mucus from the lungs. The changes induced in the system, from the primary effects of expectorants, are, an alteration in the state of the mucus excreted to a more thin and fluid consistence; an increase of the sensibility of the lungs; free circulation through the blood-vessels of the secreting glands; and the evacuation of those cavities in the lungs in which mucus is deposited.

Expectorants may be divided into the nauseating, as squills, gum-ammoniac, and garlic; the antispasmodic, as blisters, feet, and vapour-baths; and irritative, as acid vapours, and the common smoking of tobacco. The indications these medicines are capable of fulfilling may be traced as follows: 1. From their affecting the secretion of mucus; whence they may be used, to promote the secretion of mucus by the lungs, when morbidly diminished there; to render the mucus of the lungs thinner, when morbidly thick and viscid. 2. From their affecting the excretion of mucus; whence they may be employed, to evacuate morbid accumulations of mucus in the lungs; to supply irritation to the lungs when morbidly deficient. 3. From their affecting the state of the lungs themselves; whence they may be employed as local stimulants. The cautions to be observed in the employment of expectorants, as derived from their nature, chiefly respect their operations as exciting nausea; their power of stimulating the system in general from acting on the stomach; and their influence as irritating the lungs themselves. The conditions of the system which chiefly require attention in their employment are, the degree of irritability with which the lungs are endowed; and the youth of the patient. The circumstances chiefly to be attended to in the regimen necessary for this class, are, the state of the stomach; the employment of diet fitted to conspire with the effect of the medicine; the free use of exercise; and the state of the atmosphere in which the patient breathes.

The different individuals belonging to the class of expectorants, are chiefly contra-indicated by the presence of the following morbid states; a high degree of increased sensibility in the lungs; and an uncommonly quick excretion of mucus from the lungs.

3. *Of Diaphoretics.*

These are medicines, which, taken internally, increase the discharge by the skin, without exciting this effect in consequence of violent agitation or acute pain. The following are their direct results: they accelerate the motion of the blood; produce free circulation through the vessels on the surface; and excite a discharge of sweat. The changes induced in the system, from the more immediate effects of diaphoretics, are, a change in the balance of the circulation; a diminution of the quantity of circulating fluids; and a diminution more particularly of the serosity.

Diaphoretics may be regarded as pungent, of which we have instances in spirit of hartshorn, oil of lavender, or amber; stimulant, as various preparations of antimony and quicksilver, guiacum, contrayerva, and snake-root; antispasmodic, as musk, opium, and camphor; and diluent, as water and whey. Their use and indication may be collected, 1. From their changing the mode of circulation; whence they may be employed, to obviate morbid determination taking place to the internal viscera; to remove various causes obstructing or impeding the natural state of circulation on the surface; to restore the natural discharge from the body, which should take place by the surface, in those cases where it is morbidly diminished. 2. From their producing evacuation; whence

they may be employed, to diminish the quantity of circulating fluids, where it is greater than the state of the system at the time can admit of; to restore diminished lymphatic absorption, and to discharge morbid accumulations of serum. These indications may be illustrated and confirmed, from practical observations concerning the effects of diaphoretic medicines in fever, dysentery, rheumatism, dropsy, and herpes.

The cautions to be observed in the employment of diaphoretic medicines, as derived from their nature, chiefly respect the determination they produce to the surface; the acceleration of the motion of the blood, which many of them occasion; the debility which, in consequence of the discharge, is produced in the system; and the effects sometimes produced on the vessels of the surface themselves, by the free passage of the blood through them. The conditions of the system, which chiefly require attention in their employment, are, the period of infancy; lax and debilitated habits; constitutions liable to costiveness.

4. *Of Diuretics.*

These are medicines which, from being taken internally, augment the flow of urine from the kidnies, by stimulating its secretion from the mass of circulating fluids. The changes induced in the system from these direct effects, are, a change in the balance of circulation; a diminution of the quantity of circulating fluids; but more especially of the serosity and of the saline parts of the blood; an increase of absorption by the lymphatic vessels; a diminution of the quantity of matter discharged by perspiration; and an uncommon flow of fluid through the urinary passages.

Diuretics may be divided into such as are stimulant, of which we have instances in squills, broom, colchicum, cantharides; refrigerant, as sorrel, berberry, vinegar, cream of tartar; and diluent, as water, whey, and acidulated waters. Their use and indication may be ascertained from the following effects: 1. Their producing evacuation; whence they may be employed to remove superabundant serosity from the blood; to evacuate morbid accumulations of serum; to remove morbid acrimony from the blood; to diminish the quantity of circulating fluids, when too great for the state of the system at the time. 2. From their altering the mode of circulation; whence they may be employed, to restore the natural secretion of urine, when morbidly diminished; to diminish other secretions, when morbidly augmented. 3. From their augmenting the flow of liquid through the urinary passages; whence they may be employed, to remove obstructions in these passages, and to wash out acrimony from them. These indications may be illustrated by an attention to the effects of this class of medicines, as employed in ascites, ictorus, and nephritis.

5. *Of Cathartics.*

These are medicines which, taken internally, increase the number of stools, by stimulating the alimentary canal, increasing the peristaltic motion of the intestines, and promoting the secretion of the fluids which constitute alvine evacuations. They may be subdivided into the following tribes: stimulant, as jalap, aloes, bitter-apple; refrigerant, as Glauber's salts, sal polychrest, cream of tartar; astringent, as rhubarb, rose-leaves; and emollient, as manna, mallows, castor oil.

The changes induced in the system from the primary effects of cathartics, are, the evacuation of the contents of the intestines; a diminution of the quantity of circulating fluids, and, in a particular manner, of the serosity; a change in the balance of circulation; a diminution of perspiration; higher excitement of the nervous energy in the system in general, but more especially in the intestinal canal.

The indications which cathartic medicines are capable of fulfilling, may be derived from the three following sources: 1. From their producing evacuation; whence they may be employed, to obviate morbid retention of the contents of the intestines; to diminish the quantity of circulating fluids when too great for the then state of the system; to evacuate morbid accumulations of serum. 2. From their altering the balance of circulation; whence they may be employed to promote free circulation through the intestines, in those cases where it is morbidly impeded; and to diminish the impetus of the blood against parts morbidly affected. 3. From the affection of the nervous system which they occasion; whence they may be employed to remove torpor in the muscular fibres of the intestines; and to restrain inordinate motions in their muscular fibres. These in-

dications may be illustrated and confirmed, from considering the effects of this class of medicines, as employed in dysentery, small-pox, dropsy, obstructed menstruation, and diarrhœa.

The cautions to be observed in the employment of cathartics, as derived from their nature, chiefly respect the degree of evacuation they produce from the circulating fluids, and the topical irritation they occasion to the intestines themselves. The conditions of the system which chiefly require attention in their employment, are, childhood, female habits, hysterical constitutions, high degrees both of irritability and torpor, remarkable delicacy of the stomach and peculiar antipathies. The circumstances chiefly to be regarded with respect to the regimen necessary for this class, are, the mode of exhibiting the cathartic; the time at which it is given; the temperature in which the patient is kept during its operation; the diet employed; and the degree of exercise he uses.

The morbid conditions, contra-indicating the use of cathartic medicines, apply only to particular orders. The stimulant, refrigerant, and astringent, are contra-indicated by general inanition of the system; the stimulant, by a high degree of irritability in the intestines, and by morbidly accelerated circulation; the refrigerant, by a circulation unusually slow and languid; the astringent, by habitual costiveness; and the emollient, by uncommon relaxation of the bowels.

6. *Of Emmenagogues.*

By emmenagogues are meant medicines which possess a power of promoting that periodical secretion from the uterus, which should take place in certain conditions of the female frame. The following, therefore, are their effects: They stimulate the whole circulating system. They stimulate, in a particular manner, the vessels in the neighbourhood of the uterus; and this effect seems, in some degree, to be communicated to the vessels of the uterus themselves. They occasion a particular affection of the whole nervous system. The changes induced in the system from the primary effects of emmenagogues, are, an increase in the impetus of the blood circulating through the uterus and its neighbourhood; and an augmentation of the quantity of blood determined to the uterus. From some individuals referred to this class, there arises an increase of the tonic powers of the vessels in the uterus, and from others a diminution of it. Emmenagogues may be divided into the following tribes: stimulant, as various forms of quick-silver and antimony; irritant, as aloes, savin, cantharides; tonic, as iron, cold-bath, corporeal exercise; and antispasmodic, as assafœtida, castor, warm foot-bath.

Their indications may be thus traced: 1. From their changing the mode of circulation, whence they may be employed to free the circulatory system in the neighbourhod of the uterus when obstructed there; to promote that accumulation of fluid in the vessels of the uterus themselves, which is necessary to the menstrual discharge: and to remove morbid obstructions to the passage of blood into the cavity of the uterus. 2. From their acting on the state of the animated solids. Hence they may be used, to increase the tonic power of the system where it is morbidly diminished. To increase the tonic power in the vessels of the uterus in particular, when deficient there. To remove spasmodic stricture taking place on the vessels of the uterus.

Practical observation in different cases of obstructed menstruation, arising from different causes, will illustrate and confirm these various indications.

The cautions to be observed in the employment of emmenagogues chiefly respect the consequences of a cure if urged too precipitately or violently; the irritation produced to the intestines, and the stimulus affecting the whole system. The conditions of the animal frame which require attention in their employment, are, the age of the patient; the complaints to which she has formerly been liable; the duration of her present complaints; and her general character. The circumstances chiefly to be attended to in the regimen necessary, respect the temperature in which the patient is kept; the use of moderate exercise; and the employment of liberal diet.

In enumerating the morbid conditions contra-indicating emmenagogues, a distinction is to be made betwixt those which contra-indicate the restoration of the discharge altogether, and those which contra-indicate particular modes of restoring it. As morbid conditions, which entirely contra-indicate the restoration of this discharge, we may mention extreme debility, either constitutional, or induced by previous disease, which prohibit our attempting its restoration so long as the debility continues. The time of critical discharges; high degrees of

irritability and torpor; and a constitutional disposition to *deliquium animi.* The circumstances chiefly to be attended to in the regimen necessary, respect the adapting the diet and temperature to the disease under which the patient labours; the time of performing the operation; the state of the ingesta at that time; and the mode of the discharge.

7. *Of Errhines.*

These are medicines which, when topically applied to the internal membrane of the nose, excite sneezing, and increase the secretion, without any mechanical irritation. They may be regarded as of two kinds; sternutatory, or those used for the purpose of general agitation, chiefly, as tobacco, snuff, hellebore, euphorbium; and evacuant, or those designed to produce determination of the fluids to the nostrils, as asarum, beta, betonica.

The changes induced in the system, from the primary effects of errhines, are, violent agitation of the body; commotion of the nervous system; sudden changes in the circulation; a diminution of the quantity of circulating fluids; more free circulation through the mucous glands, on which the errhine acts; a change in the balance of circulation subsisting between these and the neighbouring parts.

The use of errhines may hence be ascertained by the following results: 1. From their producing agitation of the system in general; whence they may be employed to discharge morbid accumulations of mucus in the cavities surrounding the nose; to remove a state of torpor in the nervous system; to obviate nervous affections of the convulsive or spasmodic kind. 2. From their producing determination to the nose. Whence they may be employed to promote the secretion of mucus in the nose when morbidly diminished; and to occasion derivation from parts morbidly affected in the neighbourhood of the nose. These indications may be illustrated and confirmed from practical observations concerning the effects of this class of medicines when employed in cases of apoplexy, palsy, head-ach, and opthalmics.

The cautions to be observed in the employment of errhines, as derived from their nature, respect chiefly, the agitation they produce in the system in general, and the change they occasion in determination, whether as producing a greater flow to the nose, or derivation from other parts. The conditions of the system chiefly requiring attention in the employment, are, infancy, old age, irritable and hæmorrhagic habit, those which are morbidly torpid, and those formerly accustomed to the frequent use of the same stimulus. The circumstances to be attended to in the regimen necessary, respect the means of obviating inflammation when excited, and the avoiding sudden exposure to cold air.

The different individuals belonging to the class of errhines, are chiefly contraindicated by the presence of the following morbid states: a high degree of plethora; morbid debility of the viscera; uncommon sensibility of the nose; preternatural determination to the nose; and ulceration of the nose or of neighbouring parts.

8. *Of Sialagogues.*

Sialagogues are medicines which excite an uncommon flow of saliva. They stimulate the salivary glands, or their excretories. They increase the action of the vessels secreting saliva. They accelerate the circulation through the salivary glands, and through the blood-vessels in the neighbourhood of these. They produce a preternatural discharge of saliva, both in point of quantity and consistence. The changes induced in the system, from the primary effects of sialagogues, are, a change in the distribution of the fluids circulating through these vessels to which the action of the sialagogue extends, and through the vessels in the neighbourhood of these; a diminution of the quantity of circulating fluids in general; and a change in the state of the remaining mass, independently of the diminution of quantity. They may be distributed into topical, as squills, tobacco, peppers and other aromatics; and general, as mercurial preparations.

The use of sialagogues may be determined as follows: 1. From their effects as changing the balance of circulation, whence they may be employed to diminish the impetus of the blood against parts morbidly affected in the neighbourhood of the salivary glands; to diminish the action of the vessels when morbidly increased in these neighbouring parts; to promote free circulation of the blood through the salivary glands, when morbidly obstructed there. 2. From their effects, as producing evacuation, whence they may be employed to evacuate morbid accumulations of serum; to produce a

thorough change in the fluids of the body, when morbidly vitiated.

These uses may be illustrated from practical observations in cases of tooth-ach, angina, dropsy, and siphilis.

The cautions to be observed in the employment of sialagogues, as derived from their nature, respect chiefly the stimulus they occasion to the salivary glands and neighbouring parts; the time required by the order of interna for the production of evacuation; the difficulty, perhaps, in some cases, the impossibility, of exciting salivation by means of the interna; and the debility induced in the system from excessive evacuation. The conditions of the system chiefly requiring attention in their employment, are, old age, constitutions habituated to sialagogues; peculiarities in constitution, determining the mercury to act on other parts than the salivary glands; menstruation; and pregnancy. Sialagogues are contra-indicated, where there is an uncommon determination to the salivary glands; preternatural sensibility in them; deficient serosity; and general debility of the system.

9. *Of Emollients.*

By emollients are meant medicines which have a power of relaxing the living animal fibre, independently of mechanical action; they render the part to which they are immediately applied more soft and flexible than it was before. They excite a peculiar sensation indistinctly referred to the part to which they are applied; they produce through the rest of the system an effect, in some degree analogous to that taking place in the part on which they more immediately act. The changes induced in the system from the primary effects of emollients are, a dimunition of the power of cohesion in various parts of the animal body; a diminution of the tonic power in the system; an increase of the capacity of containing vessels in the part on which they more particularly act, and in some degree in the system in general; and an increase of irritability and sensibility through the entire frame.

They may be regarded as humectant, of which we have examples in warm water, warm vapour, and warm baths; laxative, as marshmallows, mallows, white lily root; lubricative, as bland oils, suet, hog's lard; atonic, as opium, foot-bath.

The curative indications of emollients may be collected hence: 1. From their producing a change in the state of the moving solids. Hence they may be employed to restore the natural flexibility to parts morbidly rigid; to diminish a morbid increase of tonic power. 2. From their producing a change in the state of the containing vessels. Hence they may be employed, to obviate the effects of morbid distention; to remove obstructions. These indications may be illustrated and confirmed, from practical observations concerning the effects of this class of medicines, as employed in cases of contraction, rigidity, and tumor. The cautions to be observed in the employment of emollients, as derived from their nature, chiefly respect their influence as acting on the system in general; and the effects of a degree of laxity induced in particular parts, higher than is natural to these. The conditions of the system which chiefly require attention in their employment are, the period of youth; delicacy of habit; and debility. The circumstances chiefly to be attended to in the necessary regimen, respect the temperature and air in which the patient is kept; and the mode of applying the emollient. The class of emollients are chiefly contra-indicated by the presence of the following morbid states: a high degree of morbid relaxation in the system in general; and a peculiar sensibility of the moving fibres.

10. *Of Refrigerants.*

These are medicines which, as their name implies, are supposed to diminish the heat of the living body, not by the application of an actual cold, but by a power peculiar to themselves.

They may be considered under the two divisions of acids or acetous fruits, as tamarinds, berberries, lemons, wood-sorrel; and neutral salts, as nitre, Glauber's salt, sal polychrest. They may hence be usefully employed; 1. In cases of febrile heat, or of general plethora, and an useful auxiliary to the tribe of refrigerant cathartics. 2. As sedatives, to diminish undue irritability and action of any of the vascular systems, and are hence usefully conjoined with the sedatives, more properly so called, of Class XV. of this system. In the employment of these medicines attention should be paid to their power of diminishing action, and either generally checking the secretions of the system, or augmenting some by a diminution of others. Hence they are contra-indicated in cases of chlorosis,

leucophlegmatic habits, and predispositions to dropsical affections. We enlarge the less, however, upon this subject, because the indications and contra-indications are closely connected, as we have just observed, with the articles and the remarks offered upon Class XV. of which, in various systems of therapeutics, they merely constitute a separate division.

11. *Of Astringents.*

These are medicines which possess a power of condensing the animal fibre without the aid of mechanical action. In general they are found to excite a peculiar sensation referred to the part to which they are applied; if to the organs of taste, a sense of dryness. They produce a remarkable corrugation in the parts on which they more immediately act. They occasion, in some degree, a similar affection through the rest of the system. Some individuals belonging to this class produce an evident condensation in dead animal fibres. The changes induced in the system, from the primary effects of astringents, are, an increase of the power of cohesion in various parts of the animal body; an increase of what may be termed the tonic power in the system; a diminution of the capacity of containing vessels in the system; a diminution of irritability, and perhaps, in some degree, of sensibility.

Astringents may be divided into styptic, of which we have examples in most metallic oxides, as well as in aluminous earths; corrugant, as rose-leaves, galls, oak-bark; indurant, as alcohol and acids; and tonic, as exercise, cold, and friction.

The indications of cure, which the class of astringent medicines are capable of fulfilling, may be deduced from the following sources. 1. From the alteration they produce on the state of the moving solids: whence they may be employed, to obviate original delicacy; to restore natural compactness to parts morbidly relaxed; to restore diminished tonic power; to diminish mobility when morbidly increased. 2. From the alteration they produce on the state of the containing vessels: whence they may be employed, to diminish secretions morbidly augmented; to increase the power of retaining excrementitious matters when morbidly diminished; to produce a constriction on the orifices of ruptured vessels.

These indications may be illustrated and confirmed from practical observations concerning the effects of astringents in cases of histeria, epilepsy, hæmorrhage, and diarrhœa.

The cautions to be observed in the employment of astringents, as derived from their nature, chiefly respect the stimulant and caustic powers possessed by many individuals belonging to the class: the effects of an alteration produced in the solids, if carried beyond the natural state; and, in a particular manner, their influence as diminishing secretions; and as increasing the power of the system for the retention of excrementitious matters. The conditions of the system which chiefly require attention in their employment, are, old age, melancholic habits, and particular morbid affections of the stomach. The circumstances chiefly to be attended to in the regimen necessary, respect the avoiding a relaxing diet; and the keeping the patient in a cool temperature and dry air.

Astringents are chiefly contra-indicated by the presence of the following morbid states; a high degree of rigidity in the system in general; remarkable insensibility in the moving fibres; and particular diminution of the excretions from the body.

12. *Of Tonics.*

The medicines thus denominated are those which increase the tone of the muscular fibre, are supposed to brace the system when constitutionally relaxed, and give it vigour when debilitated by immediate disease. They may be divided into stimulants, as various preparations of mercury, iron, zinc, and other metals; and astringents, as chamomile-flowers, myrrh, Peruvian, and other barks, and gentian. It is hence obvious, that this class of medicines has a near relation to those noticed in the class that immediately precedes, and immediately follows it. On which account we shall dismiss it with a single additional observation or two. The changes induced in the system by the use of tonics are, increase of muscular power, greater moderation, and a firmer stroke of the pulse, increased desire for food, and an augmented vivacity of the animal spirits. Hence their use is clearly indicated in all cases in which there is a deficiency of these natural powers or desires. They are therefore contra-indicated by the ex-

istence of a plethoric habit, constitutional predisposition to maniacal affections, or topical hæmorrhage, and a sanguineous temperament.

13. *Of Stimulants.*

These, like the last, are medicines which have a power of exciting the animal energy; but for the most part topically, rather than generally, or for a shorter period of time. They occasion a particular sensation referred to the part more immediately acted upon; frequently a sense of pain; they increase the action of muscular fibres in that part, particularly in its vessels; they increase the energy of the sensorium; they increase the nervous energy in the moving fibres through the system in general. The changes induced in the system from the primary effects of stimulants, are, acceleration of the motion of the blood in the part to which they are particularly applied; an increase of the force of circulation in the system in general; an increase of excitement in the powers of sensation; and an augmentation of mobility and vigour in the muscular organs. They may be divided into the following heads: topical, of which we have examples in mustard-seed, cantharides, mercurial preparations; diffusible, of which we have instances in volatile alkali, electricity, heat; cardiac, such as cinnamon, nutmegs, and other spices, and wine.

The indications of cure which stimulants are capable of fulfilling, may be derived from the three following sources: 1. From their affecting the state of circulation: whence they may be employed, to facilitate the passage of blood through parts in which it is morbidly obstructed; to augment the force and celerity of the circulation, where it is morbidly slow and weak. 2. From their acting on the powers of sensation: whence they may be employed, to quicken the senses where morbidly dull; to rouse the mental faculties when in a lethargic state; to exhilarate a despondent condition. 3. From their acting on the moving fibres: whence they may be employed, to restore the power of motion where morbidly deficient; to increase the strength of motion where morbidly weak. These indications may be illustrated and confirmed from practical observations concerning the effects of this class of medicines, as employed in cases of syncope, apoplexy, and palsy. The cautions to be observed in employing stimulants, are, the pain they excite, the violence of circulation, or the flow of the animal spirits which they produce, the mobility of the system which arises from their employment, and the collapse, which is the consequence of high and sudden excitement. The conditions of the system, which chiefly require attention in their employment, are delicate and irritable habits. The circumstances chiefly to be attended to in the regimen necessary, respect the diet and temperature best adapted to the stimulant employed, and the nature of the particular disease in which it is used. The individuals belonging to this class are chiefly contra-indicated by the presence of the following morbid states: a high degree of morbid irritability; the circulation uncommonly accelerated; and a preternatural disposition to hæmorrhage.

14. *Of Antispasmodics.*

By these are meant whatever has a power of allaying inordinate motions in the system, particularly those involuntary contractions which take place in muscles naturally subject to the command of the will; they counteract and remove various causes exciting contractions; they diminish the influence of the nervous energy in the parts spasmodically affected. The changes induced in the system, from the primary effects of antispasmodics, are, the restoration of the proper balance of the nervous energy in different parts of the body, the restoration of the due influence of the will, and the restoration of the natural state of tension to the muscles. The different articles referred to the class of antispasmodics may be distributed into the two following orders: stimulant, as volatile alkali, essential oils, ether; sedative, as camphor, musk, opium.

As the action of the medicines referred to this class, depends entirely upon the presence of a morbid state, what has been advanced with regard to their nature, will, in a good measure, serve to illustrate their use. The indications of cure which, as antispasmodics, they are capable of fulfilling, are entirely to be derived from their influence on the nervous energy: whence they may be used, to remove spasmodic contractions taking place in different muscles, to allay convulsive agitations. These indications may be illustrated and confirmed from practical observations concerning the effects of antispasmodics, as employed in cases of epilepsy and cramp. The circumstances claiming attention in the employment of antispasmodics, which respect either the

nature of the medicine itself, the condition of the patient in whom it is used, or the necessary regimen, are different according to the particular order which is employed. They will easily be understood, from what has already been said of stimulants and sedatives, considered as separate classes.

There is, perhaps, no condition of the body which will contra-indicate the use of every individual referred to the class of antispasmodics. But the same morbid conditions, which have already been mentioned, as contra-indicating the use of stimulants and sedatives, will likewise contra-indicate the orders of antispasmodics denominated from these classes.

15. *Of Narcotics.*

These are medicines which have a power of diminishing the animal energy, and hence inducing torpor and sleep, during which this energy is usually recruited and restored. They diminish the sensibility of the part to which they are particularly applied. They diminish the action and tonic power of its muscular fibres. They produce a peculiar sensation in the system in general. They diminish the energy of the sensorium.

The changes induced in the system from the primary effects of narcotics are, retardation of the blood's motion in the part more immediately acted upon: diminution of the force of circulation in the system in general: diminution of excitement in the powers of sensation and reflection: and diminution of vigour in muscular action through the system.

Narcotics may be divided into those which act directly, and those which act indirectly. Of the former tribe are poppies, opium, hyoscyamus, hops, and lettuce; of the latter, neutral salts and acids. Their use may be calculated from the following sources: 1. From their affecting the circulation; whence they may be employed to diminish the force and celerity of the blood's motion where morbidly augmented; to diminish the impetus of the blood against parts morbidly affected. 2. From their acting on the powers of sensation; whence they may be employed to abate violent pain; to procure sleep, in cases of preternatural watchfulness. 3. And from their acting on the moving fibres; whence they may be employed to restrain inordinate motions, and to moderate excessive evacuations. These indications may be illustrated and confirmed from practical observations concerning the effects of this class of medicines, as employed in cases of inflammation, tooth-ach, and dysentery. The cautions to be observed in the employment of this class of medicines, as derived from their nature, chiefly respect the insensibility which they produce; the atony they occasion in the muscular fibres, particularly in the blood-vessels; and the suspension of the powers of sensation with which they are sometimes followed. The conditions of the system which chiefly require attention in their employment are, irritable and relaxed habits; and such as are constitutionally liable to delirium from their use. The circumstances chiefly to be attended to in the necessary regimen, respect the regulation of the dose of the medicine employed; the avoiding all stimulating causes during their operation; and the guarding against their becoming habitual to the system. Narcotics are chiefly contra-indicated by a preternaturally languid circulation; a peculiarly lethargic disposition, and great morbid torpor in the system.

16. *Of Anthelmintics.*

By anthelmintics, are meant those medicines which, without endangering the life of the patient, are effectual in procuring the removal of worms lodged in the human body. The direct effects arising from this class of medicines are intended to be exerted only on the worms themselves; but there are at the same time few, if any, medicines, which, when employed with this intention, do not also produce some effect on the animal body: to enter upon the consideration of these, however, would be foreign to this class. As anthelmintics they produce the following effects. They kill worms to which they come to be applied in the body. They expel them from the body. They prevent their generation in the body. The only changes produced in the system, that are here to be considered, are those which arise from their action upon the worms themselves. These are, the removal of an almost infinite variety of different symptoms which worms produce whilst lodged in the body. Anthelmintics may be subdivided into the following tribes: *poisonous*, as quicksilver, tin, sulphur; *lubricant*, as oil of olives and oil of linseed; *tonic*, as savin, tansy, santonicum; *cathartic*, as scammony, jalap, aloes, gamboge. Their indications are manifested from the following considerations: 1. From their action on the worms themselves; whence they may be employed

to kill worms lodged in different parts of the human body. 2. From their action on the system; whence they may be used to promote the expulsion of worms from the body, whether dead or alive; to prevent the generation of worms in the body. These indications may be illustrated and confirmed from practical observations concerning the use of anthelmintics in cases of atrophy, diarrhœa, and vomiting.

The cautions to be observed in the employment of anthelmintics, as derived from their nature, chiefly respect the other effects they have upon the system, independent of their action as anthelmintics. The conditions of the system which chiefly require attention in their employment are, infancy, delicacy of habit, and other similar affections. In the regimen, farinaceous food should be avoided; and exercise should be encouraged.

There are, perhaps, no morbid conditions of the system, during which the removal of worms from the body may not with propriety be attempted by one mean or other. But although it may be doubtful whether there be morbid conditions contra-indicating the whole class, yet it cannot be questioned that there are many contra-indicating particular orders. Among others may be mentioned: an abraded or inflamed state of the intestines, contra-indicating the poisonous; accumulations of feces in the first passages, contra-indicating the lubricant; a peculiar sensibility of the stomach, contra-indicating the tonic; and topical inflammation of the intestines, previous looseness, or a high degree of inanition, contra-indicating the cathartic.

17. *Absorbents.*

This term is used differently by different therapeutists. Generally speaking, it implies medicines which, possessing no acrimony in themselves, possess, notwithstanding, a power of destroying acidities in the stomach and bowels: at other times, however, it is employed more largely to indicate those substances, as well, which increase the general action of the absorbent system. They may hence be divided into two kinds: the calcareous, as burnt hartshorn, oyster shells, and chalk; and stimulative, as burnt sponge, salt of hartshorn, and alkalies. They are hence indicated in peculiar acrimonies, or peculiar torpidities of the system generally, or particular organs of the system; and may hence be employed beneficially in acidities of the stomach, heartburn, and excesses in a vinous potation; as well as in strumous and other leucophlegmatic affections of the glandular system; especially in bronchocele, or the disease termed provincially Derbyshire-neck, and scirrhosities of either extremity of the stomach. Their use may be collected from practical attention to these diseases, in which, notwithstanding, they commonly require to be connected with more active applications. On this last account they may generally be employed without apprehension: yet in cases of acidity of the stomach, they have often been used to an extent that has produced worse diseases than the malady they were intended to remedy, and have laid the foundation for calcareous concretions, that have resisted the application of almost every purgative, and formed indurations almost as troublesome as the calcareous concretions of the bladder: concretions which have only been removed by a long use of active lithontriptics.

MATHEMATICAL *instruments.* Under this term we shall treat of the instruments usually sold in cases, and made on a portable plan, so as to fold up into a small space, to be carried in the pocket without injury to any part. These cases are made either vertical, or horizontal; but the latter mode is far preferable, although the bulk is, in this form, somewhat augmented, because the points are kept in a better state of security; an object of the utmost importance to the mathematician, since the excellence of the compasses, and drawing pens in particular, will, in a great measure, depend upon the delicacy of their terminations. The whole of the steel-work in a case of instruments should be of the best finish, duly tempered, and fitted with scrupulous exactness; the hinges in every part should fit close and firmly; having screw-pivots, in order that they may be taken to pieces on occasion. The screws ought to fit into female sockets of steel; those of brass being extremely liable to wear out in the thread, or worm, and to cause the parts that depend on their motion to be lax and uncertain. The protractor and sector should be of very fine clear ivory, and the parallel ruler may be of the same, or of ebony: but which ever it may be made of, the utmost care must be taken to preserve it from warping, while its edges, as well as those of the other flat instruments, ought to be guarded from injury. The protractor, especially, should never be touched by a knife, or by any sharp or hard instrument, when drawing lines

along its edge. When describing its uses, the reader will collect proper ideas regarding the absolute necessity for preserving its edges from the smallest diminution or irregularity; since the most trivial defect therein could not fail to render the whole of its operations precarious. We are disposed to think that the flat instruments are usually made rather too thin, whence they are easily warped by change of weather, or by being kept in too warm a situation; leaving them exposed to a hot sun is extremely injudicious.

Having said thus much respecting the materials of which they should be formed, we shall detail the uses and proportion of each instrument separately. The pencil ought to be of very pure lead, such as is free from ore, and that cuts to a fine point without offering too much resistance to the knife; the surface of the lead should, when cut, appear very smooth and glossy, without any flaws, or resemblance of antimony: the mark left on paper should be perfectly superficial, and exempt from any impression or scratch, which bad pencils invariably make, and which cannot be erased or defaced without giving the paper a rough surface, and a disposition to absorb; so as to shew blotty when colours are used. Some judgment is required to distinguish the fine pencils, made of solid lead ore, from those which are vended by Jews, and, indeed, by some who call themselves respectable manufacturers of this article. The inferior kind are made of black-lead dust, cemented with glue, gum, starch, linseed-tea, and a variety of such adhesive matters, according to the degree of hardness the composition is intended to bear. When we see "hard lead," and "soft lead," impressed on the cedar casings of black-lead pencils, we may generally suspect their quality; for though the best makers occasionally make a distinction in regard to the hardness or softness of the lead, they usually sort such into different chests, and vend to the retailers according to their fancy, or to the predilection shewn by their respective customers. We, therefore, recommend to persons wishing to obtain good black-lead pencils, that they purchase by the gross, from the most eminent makers; or that they give a good price for them at those warehouses where articles in the drawing line are sold in perfection. In tapering a pencil to a fine point, it is necessary, after the shape may have been generally given, to hold the point against the inside of the tip of the fore-finger of the left hand, cutting from you very carefully, and turning the pencil round as may be necessary. By this means the point is supported, and may, when the lead is very good, be made to taper beautifully, without danger of being broken by the operation.

The compasses given in a complete case vary, being intended for various different purposes. First, a pair of hair-compasses, so called, because, by means of a screw near the middle of one limb, a spring, which unites with the steel leg, may be acted upon so gradually, as to cause the points to give the most precise measurements. When compasses are relaxed too much at the joint, they should be tightened by means of two little apertures that are on each side of the pivot-head. In these the two small studs that appear on the turnscrew are applied, either to pinch tighter, by turning with the sun; or to relax, and even to separate the two limbs, by turning against the sun. If the points of compasses are not duly tempered, they will prove very troublesome; when too brittle, they will be perpetually snapping; and when too soft, they will be subject to bend. The mathematician will occasionally have to work on substances harder than paper; therefore the temper of his points is a matter of some importance. If too highly tempered, he should heat them near the flame of a candle until they change to a straw colour, when they ought to be instantly plunged into a lump of soap, or of tallow, &c. When too soft, let the points be heated to a bright red, and then be suddenly immersed in water in which salt-petre has been dissolved. The points of compasses ought to be very even, and the two sides that lay together, when they are closed, should never be ground, or rubbed, except to take off the rough point sometimes occasioned by setting the two other sides of each point. The puncture made by compasses ought to be barely visible; consequently the points should be extremely fine: hence also we see the necessity for avoiding to press upon compasses while measuring on paper, &c. as their own weight will, generally, cause them to leave a sufficient impression for mathematical purposes.

Besides the hair compasses, there is usually a rather longer pair, of which one of the steel legs draws out altogether, for

the purpose of being replaced by a brass limb, with a port-crayon, a dotting-leg, &c. The former has a pair of clasp-springs, acted upon by a ring of the same metal, to secure a piece of fine black-lead pencil, which should be cut to a fine point, exactly level with the other leg of the compass. This is meant for drawing circular lines. The dotting-leg is for making dots in circular figures, and bears a small brass graduated wheel between two side-pieces, from which it derives its supply of ink. The dotting-leg is, however, best used dry; when the marks made by the impression of the gradations on the wheel may be followed by a pen. The wheel is apt to let the ink fall, and to make sad blotted work. A third limb is likewise applicable in this instance, *viz.* a drawing pen, intended to make ink lines in circular figures; the sides of this are two steel slips, bending towards each other at their ends, which are finished so as not to cut the paper, but to make a line of any strength, according as the ink may be allowed to pass, more or less freely, by the expansion or contraction of their points, as acted upon by a small screw about the middle of their bend.

There is also a neat small pair of compasses intended for drawing circles, &c. of a small diameter; in these there is only a fixed drawing limb, in lieu of a plain steel leg: they are highly convenient when the longer compasses are in use for dotting, and are capable of doing the work, which comes within a small radius, to great nicety; not being so apt to jump as those of a longer size, when the circles are very small. The inventor of this instrument was named Bowes, whence it bears that designation; though some have vulgarly corrupted it to "bow-compasses."

The proportional compasses consist of two flat brass limbs, both of which bear steel points; a screw, sliding in a groove, connects them; and by being tightened at pleasure enables the operator to slide the bridge along so as to be fixed at any point on the lateral tables. When closed, the two limbs, and their respective points, appear but as one piece, and are kept to that position by a small stud in one, which fits into the other half. This instrument must be perfectly closed before the bridge is moved, else the channels of the two limbs will not lay in a right line. Four tables are engraved on these compasses, *viz.* on one side a table of circles, on the other side (of the same face) a table of lines. By applying the index on the bridge to the several lines, as numbered in the former table, the radius of a circle being taken between the long points, at one end of the compasses, the shorter points, at the other end, will give such part of the circumference as the bridge may be placed against: thus, if the seventh part of a circle be required, close the compasses and slide the bridge, bringing the mark on it into an exact line with the mark at 7 in the table of circles; then screw rather tight, and open the long points equal to the radius of the circle; the other points will give a measurement, between their points, equal to a seventh part of that circle's circumference; and give the face of a regular polygon of seven sides.

The proportional parts of lines are ascertained in the same manner, by setting the index to that table, the long points measuring the whole line, and the short ones giving the part required, according to the figure against which the index on the bridge is set.

The line of planes, or of squares, shews the areas under the different figures: thus, set the index to four, the measure between the long points will give a square four times as large (in contents) as a square made with the measure between the small points on one of its sides: thus, if the square made on the latter contained six square inches, that made on the former would give an area equal to twenty-four square inches.

The line of solids shews, in the same manner, the difference between the solid contents of bodies of a regular figure; in this case, however, the bodies must be similarly quadrangular, such as cubes; or spherical, as balls, globes, &c.; then, by taking their diameter, the table will indicate the difference of their solid contents; the small points being considered as implying unity.

Triangle-compasses are made for the purpose of ascertaining three points, in the same manner as the common biped-compasses ascertain only two. This is effected by a third leg, which may be taken off at pleasure, working like a gin for raising weights; or like the legs of a theodolite-stand, and having a hinge at right angles with that where it joins the top of the compasses. By this simple contrivance the added leg may be made to incline to the right or left of the direction given by the upper hinge.

Where work is to be executed on a large scale, *viz.* projecting meridians in maps, it is necessary to have a very

large pair, such as are known at the makers by the designation of beam-compasses: these may be had in separate cases, with covers sliding in grooves, and to the extent of full two feet in length. In some professions such are indispensable, but it is far more convenient to have a branch, or elbow-joint, to the shifting compasses; the upper part fitting into the socket made for receiving the several limbs, and its lower end being socketed in the same manner; so that one leg of the compasses may be made, to any extent, longer than the other. As all the additional joints have a hinge, the excess of length may be made subservient to any direction, by being bent downwards, so as to stand at right angles with the paper; as in such case the other leg ought also, in order to prevent its shifting, or cutting the surface. The elbow-joint is often given in a flat case of instruments.

The drawing-pen is ordinarily about six inches in length, and is made on the same principle as that intended for circular operations; in general, this unscrews in the centre, and disengages the upper part of the handle, to which a fine steel needle is attached, the use of which is to mark down, by the slightest puncture, those points that require peculiar delicacy. The small flat steel turn-screw has one end narrowed, that it may fit the screw-heads in the hinges of compass limbs; while the other, by means of two studs that fit into corresponding holes on the side of the joint connecting the two limbs of the compass, serves to tighten or to relax them at pleasure.

The common parallel rules made to fit into cases, consist of two slips, moving upon four pivots; *i. e.* one at each end of two metal plates, whereby the slips are always kept at a perfect parallel. This chiefly depends on the perfect equality of lengths in the metal slips, and their being placed at exactly the same angle, at points equidistant from the edges of the slips. Some parallels have a third piece, which folds between the two above described, and requiring an additional pair of metal hinges, which meet on them as a centre. This is certainly a very great convenience, inasmuch as it extends the scope of the instrument, and gives a third parallel; but the slightness of the middle piece subjects it to warp; and, at all events, demands great care in using, so as not to wrench the pivots, or to bend them into an improper direction, whereby the whole work would be falsified. In drawing lines with this ruler, observe the following instructions. When a parallel is to be made above the line to which you apply the ruler, let the limbs be closed, then press firmly on the bottom slip, by two fingers placed at least two inches apart, and clear of the hinges; slide the upper limb gently from you, by means of the metal stud in its centre, until you bring it up to the point through which the parallel is to be drawn. When you would make a parallel below any given line, the slips should be separated (keeping the upper limb well pressed by two fingers) until you bring the upper or lower edge of the other limb, as may prove most convenient, to the point through which the parallel is to be made. Or you may open your ruler to its full extent; first, placing its upper thin edge along the original line, and pressing on the lower limb, then draw the upper one down to the desired point. Both the edges of this ruler are chamfered on one side only; whence one edge lays very flat to the paper, so as to guide with great exactness, and serving excellently for pencilled lines; while the other, being raised from the paper, gives greater security from blotting when ink is used, but requires a very steady hand, and a no less accurate eye.

Parallel rulers are sometimes made to move on wheels, with graduated edges, shewing the parts of inches over which they pass. The theory is excellent, but we find in this many practical inconveniences; such rulers being easily turned out of their proper directions, by any little inequality on the surface of paper, or by the smallest deviation from perfectly even propulsion, or retraction. Besides, the axis being necessarily made loose, so as to allow great freedom of motion, it is obvious the wheels cannot always preserve an exact level; whence the instrument must move as though of a conical form, and give concentrating, instead of parallel lines. Hence such rulers are deservedly discarded in most instances; though, for work requiring more celerity than accuracy, they may be found to answer.

Protractors are chiefly made of ivory, in the form of a thin flat scale, or ruler, of which one side is plain, excepting a very small nick, or mark, that points out its exact centre, and corresponds with a line, perpendicular to it, on the opposite edge, marked 90, dividing the instrument into two equal and similar portions. The edges on three sides of the protractor are

graduated with 180 degrees, backwards and forwards, the centre point 90 being a right angle. The protractor is used for laying down angles to any extent, as also for taking their measurements: hence it is of extreme service in every branch of mathematics, and indeed of mechanism. On the same side with the graduations, we generally find a line of chords on an extensive scale. We shall explain its construction when we treat of the sector, observing, in this place, that by its aid we are enabled to set off any angle without the assistance of a protractor: thus, take the measurement of 60°, from the line of chords, as a radius wherewith to describe any segment at pleasure, putting one foot of your compasses at the point whence the angle is to proceed, and commencing the segment from that line whence the angle is to be made. Take then from the line of chords the number of degrees you intend the angle should contain; set them off upon the segment from the place where it joins the line; the angle will be thus made, leaving the centre whence the radius was drawn for its point, and the two ends of the chord that cut off the segment for its measurement. See GEOMETRY and DIALLING.

Some protractors are made of brass, in the form of a semi-circle; they are precisely on the same principle, but are more calculated for the measurement than for the construction of angles; because they expose the directions of lines, however short, and enable us, by means of any right line instrument, laid from the centre to the circumference, to ascertain the angle without extending the line, as must be done when an ivory protractor is used to a short line.

On the back of the protractor there are usually six scales, marked 60, 50, 45, 40, 35, and 30; meaning, that the measures, or equal points, 1, 2, 3, &c. respectively include 60, 50, &c. such within the length of an inch; the number 1, 2, 3, &c. being considered at 10, 20, 30, &c. of such small divisions as are placed at the commencement of each scale respectively. The scale marked C, standing on the same line with that of 60 to an inch, is a line of chords on a reduced scale, for the convenience of persons working on such; and the broader scale, of 10 lines in depth, is of half and quarter inch divisions, with oblique scales at the two ends. These shew all the tenths of a half, or of a quarter of an inch, respectively, according as the oblique line gives more space between it and the first perpendicular, as may be seen by referring to the figures 2, 4, 6, 8, which shew $\frac{2}{10}$, $\frac{4}{10}$, $\frac{6}{10}$, $\frac{8}{10}$, of the division, and enable us to embrace any number of whole divisions, and of tenth parts, within our compasses, with readiness and precision. This is intended chiefly for work on a larger scale, such as ground-plans, &c.; though for such purposes, a scale divided into twelfth parts is more convenient; since it takes feet and inches, instead of decimals of feet.

It is proper to remark in this place, that the protractor should be prevented from warping, else its measurements of angles will not be true. When this defect has taken place, it will be necessary to press the instrument; thereby to bring it as flat as possible, that the measurements may be accurate, by the bearings being restored to their proper places.

The sector is made to fold in the middle, not only that it may lay in a smaller compass, but to solve many problems, by means of the references given to various tables and scales that are engraved on both sides of each limb. When opened to its full length, the sector commonly measures one foot; each inch being numbered, and divided into tenth parts, called lines. At the edge is another scale, which divides the foot into ten equal parts (numbered 10, 20, 30, &c.) because each tenth part of the foot is again subdivided into ten; thus giving a division of the twelve inches into 100 equal parts.

The first scale we shall notice is that next to the inner edges, marked Pol. meaning polygon. By opening the sector to such a width, as may admit the radius of any circle to measure exactly from the figure 6 on one, to the figure 6 on the other limb, we at once ascertain the division of that circle's circumference into any number of equal parts, from four to twelve; because, from the figure 4 to the opposite figure 4 will give a chord subtending a quadrant of the circle; from 5 to 5 will give the side of a regular pentagon, or figure of five sides; from 6 to 6 a hexagon; and so forth.

The line of chords on the sector is known by the letter C on each limb, and measures 60 degrees only; though on the protractor it goes as far as 90, which is its full measurement. This, however, is not important, as we can always add 30 to 60, and thus complete any figure in hand. The formation of the line of chords being given, its application will be more readily understood; we shall therefore shew how they are constructed from the circle.

Suppose the line A B (fig. 1, Plate Mis-

cel.) to represent the end of your scale, and that A C, B D, be perpendicular thereto: with A B as a radius, and from A as a centre, draw the quadrant B F C, and the straight line or chord B C subtending that quadrant. Divide the quadrant into 90 equal parts, and from B, as a centre, measure off each division successively, so as to cut the chord B C into 90 parts, all which will be unequal. Mark every tenth degree, both on the quadrant and on the chord, thus, 10, 20, 30, 40, 50, 60, 70, 80, and 90. This division will make the line B C a line of chords, which affords a scale of very general utility in mathematics.

The line of sines, commonly marked S, shews the relation of sines to various portions of circles. Here it is necessary to state, that there are three kinds of sines, *viz.* the sine, the co-sine, and the versed sine. The sine is that perpendicular which stands at right angles with the chord subtending an arc, and reaches from it to the circumference, such as the line E F; the co-sine is a chord, such as F G, which commences from the junction of the sine with the circumference, and is parallel with that line from which the sine arises, proceeding in that direction until intercepted by the perpendicular A C, which terminates the quadrant; the co-sine is therefore the complement or residue of the base line A B, after deducting from its other end the amount of the versed-sine B E. If from B 60 degrees be measured on the quadrant to F, its sine will divide the base A B into two equal parts; so that the co-sine and versed-sine will be of equal length. The line of sines is therefore made on the perpendicular A C by means of parallels, to the base A B, drawn from the circumference at the parts marked 10, 20, 30, &c. degrees, which of course give a regularly diminishing scale.

The line of tangents is made by a continuation of the perpendicular B D to K, and by drawing from the graduated quadrant the several lines 10, 10; 20, 20; 30, 30; &c. to that perpendicular, all pointing to the centre A. This scale regularly augments, and is carried to 45 degrees only. Now, by transferring all the tangent scale, and the places of the degrees thus obtained from the point A, by drawing segments from each part respectively to the perpendicular A H, we have a line of secants: thus the 10 on the tangent scale will be transferred to 10 beyond C on the secant line, 20 to 20, and thus to the end of the scale up to 90 degrees, which would, however, require a great length of ruler. The line of tangents is confined to 45 degrees; but a line of lesser tangents, from 45° to 90°, is made on a smaller radius.

The line of equal parts between A and B is also called the line of lines, and is divided into 10, 100, 1000, &c. equal parts; but the indicial numerals are confined to 10, for we have only ten numbers on each limb of the sector, made by dividing the radius (or base line) A B into that number of equal spaces. The uses of the lines above described are very extensive; but we shall give a brief example of their intentions, observing, that the line of equal parts is distinguished by the letter L on each limb of the sector: the line of sines, by S; the line of tangents, by T; the line of secants, by *se.*; and the line of lesser tangents, by *ta.*

N. B. In some sectors the letter C is engraved close to the very centre of the hinge, which centre is marked by an obvious puncture, towards which all the lines have a tendency: in using the lines, the measures are to be taken from those marked L. S. C. &c. on one limb to those marked L. S. C. on the other limb, respectively, they standing at an angle of six degrees from their respective partners.

"To find a fourth proportional by the line of equal parts." Say you would wish to find a line proportioned to 15 as 3 is to 8: on the line of equal parts take a distance from C with your compasses equal to 15, and with that opening extend your sector so as the distance between 3 and 3 may correspond therewith; then measure the distance thus generated between 8 and 8, and lay it from the point C along the line of equal parts: it will fall on 40, which is in the same proportion to 15 that 8 is to 3. And this is demonstrable by common arithmetic; for 3 being $\frac{3}{8}$ of 8, and 15 being $\frac{3}{8}$ of 40, the solution given by this scale must be correct. This depends entirely on the mathematical axiom; *viz.* that "parallel lines under the same angle are to each other in proportion to their respective distances from the angular point."

"To set off an angle by a line of chords of 60° only," (fig. 2.) Open the sector to any extent at pleasure, and with the distance between 60 and 60 describe a segment at least equal to the space you think the angle will occupy. On the same line of cords take on your compasses the number of degrees you intend the angle to be, say 27, and applying one leg to the commencement of your seg-

ment, (which we suppose to be a given point on a given line) measure the same space on the segment. The two points thus ascertained on the segment will shew an angle of 27 degrees; which will be better seen by drawing lines from them respectively to the centre where the segment was described. When the angle is to be more than 60 degrees, another operation on a second line, made at 60 degrees, will give the angle required: thus you may make an angle of 60 degrees in the intended direction; and if the whole angle to be made amount to 73, you may add a second angle of 13. But the neatest and shortest way is to draw a perpendicular to the given line, on the point whence the segment arises, and from that to make an angle equal to the complement: thus, if the angle is to be 73, from the base line, you should make an angle equal to 17, which added to 73 complete 90 degrees, and thus obtain the desired angle by inversion.

"A line being given, to find the sine of a segment whose radius shall be the hypothenuse of a triangle (at any given angle), formed by that line, as a base, and by the sine as a perpendicular thereto," (fig. 3.) Here we have one of the most important, yet simple, operations in mathematics; *viz.* the ascertaining a sine upon an undescribed segment. Let the base line, A B, be 174, and the given angle be 42; make the angle at one end, B, of the base, and at the other, A, raise a perpendicular which is to become the sine, when intercepted by the hypothenuse C B. Take 174 from the line of equal parts on your compasses, and open your sector until the distance between 48 and 48 on the lines of sines corresponds therewith. Now measure the distance between 42 and 42 on the lines of sines, and their result, 162, will be the length of the sine to a segment, of which the hypothenuse of the triangle is radius, and whose versed sine will be found by continuing the base line until it meets the segment: the base line in this case will be equal to the co-sine; since a perpendicular raised at the angular point parallel to the sine, A C, would, if the segment were continued thereto, complete the quadrant of a circle.

But if, instead of taking the hypothenuse for a radius, we take only the length of the base line; and from the same point as before, draw a segment, A D, from the end of the base to the hypothenuse; then, instead of being a sine, the line whose length we have just ascertained to be 162 will be a tangent, and comes under the next example.

"To ascertain the length of a tangent under a given angle, on a given line." Take the distance 174 (equal to the radius), from the line of equal parts, and open your sector, so that it may be the distance between 45 and 45 on the lines of tangents. Then take the distance from 42 to 42 on the same lines, and it will be found equal to 162 on the line of equal parts. Hence we see that the tangent of a segment made on the base as a radius is the line of a segment made on the hypothenuse as a radius; the angle in both instances being the same, and not exceeding 45°.

"To find the length of the secant in the same figure." Take the length of the base, as before, from the line of equal parts, and spread the sector until that measure reaches from 0 to 0 (that is, from the very beginning) of the lines of secants; measure the distance from 42 to 42 on the lines of secants; it will reach to 238 on the line of equal parts, and give that for the length of the hypothenuse, which is in this case considered as a secant.

Besides the lines already described, there are some that require the sector to be completely unfolded, so as to be all in one line. These are the artificial lines of numbers, sines, and tangents, taken from Gunter's tables, which depend on logarithms for the solution of their operations; as will be seen under the head of Navigation, in which the properties of Gunter's scale are illustrated.

MATHEMATICS, originally signified any discipline or learning; but, at present, denotes that science which teaches, or contemplates, whatever is capable of being numbered or measured, in so far as it is computable or measurable; and, accordingly, is subdivided into arithmetic, which has numbers for its object, and geometry, which treats of magnitude. See Arithmetic and Geometry.

Mathematics are commonly distinguished into pure and speculative, which consider quantity abstractedly; and mixed, which treats of magnitude as subsisting in material bodies, and consequently are interwoven every where with physical considerations. Mixed mathematics are very comprehensive; since to them may be referred astronomy, optics, geography, hydrography, hydrostatics, mechanics, fortification, navigation, &c. See Astronomy, Optics, &c.

Pure mathematics have one peculiar

advantage, that they occasion no disputes among wrangling disputants, as in other branches of knowledge; and the reason is, because the definitions of the terms are premised, and every body that reads a proposition has the same idea of every part of it. Hence it is easy to put an end to all mathematical controversies, by shewing either that our adversary has not stuck to his definitions, or has not laid down true premises, or else that he has drawn false conclusions from true principles; and in case we are able to do neither of these, we must acknowledge the truth of what he has proved.

It is true, that in mixed mathematics, where we reason mathematically upon physical subjects, we cannot give such just definitions as the geometricians: we must, therefore, rest content with descriptions; and they will be of the same use as definitions, provided we are consistent with ourselves, and always mean the same thing by those terms we have once explained. Dr. Barrow gives a most elegant description of the excellence and usefulness of mathematical knowledge, in his inaugural oration, upon being appointed Professor of Mathematics at Cambridge.

The mathematics, he observes, effectually exercise, not vainly delude, nor vexatiously torment, studious minds with obscure subtilties; but plainly demonstrate every thing within their reach, draw certain conclusions, instruct by profitable rules, and unfold pleasant questions. These disciplines likewise enure and corroborate the mind to a constant diligence in study; they wholly deliver us from a credulous simplicity, most strongly fortify us against the vanity of scepticism, effectually restrain us from a rash presumption, most easily incline us to a due assent, perfectly subject us to the government of right reason. While the mind is abstracted and elevated from sensible matter, distinctly views pure forms, conceives the beauty of ideas, and investigates the harmony of proportions; the manners themselves are sensibly corrected and improved, the affections composed and rectified, the fancy calmed and settled, and the understanding raised and excited to more divine contemplations.

MATRASS, CUCURBIT, or BOLTHEAD, amongst chemists. See LABORATORY.

MATRICARIA, in botany, *feverfew*, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx, hemispherical, imbricate; the marginal scales solid, sharpish; down none; receptacle naked. There are eight species. These are herbaceous plants, with leaves mostly pinnate, in some few simple; flowers terminating either in corymbs, or almost solitary; florets in the ray commonly white. M. Parthenium, common feverfew, is a native of many parts of Europe, in waste places, in hedges and walls, sometimes in cornfields and gardens, where it is also cultivated in a double state.

MATRIX, in anatomy, the same with uterus.

MATRIX, in letter-foundery. See FOUNDERY.

MATROSSES, are soldiers in the train of artillery, who are next to the gunners, and assist them in loading, firing, and spunging the great guns. They carry fire-locks, and march along with the store waggons, both as a guard, and to give their assistance in case a waggon should break down.

MATT, in a ship, rope-yarn, junk, &c. beat flat and interwoven; used in order to preserve the yards from galling or rubbing in hoisting or lowering them.

MATTER, in physiology, whatever is extended and capable of making resistance: hence, because all bodies, whether solid or fluid, are extended, and do resist, we conclude that they are material, or made up of matter. That matter is one and the same thing in all bodies, and that all the variety we observe arises from the various forms and shapes it puts on, seems very probable, and may be concluded from a general observation of the procedure of nature in the generation and destruction of bodies. Thus, for instance, water, rarified by heat, becomes vapour; great collections of vapours form clouds; these condensed descend in the form of hail or rain; part of this collected on the earth constitutes rivers; another part mixing with the earth enters into the roots of plants, and supplies matter to, and expands itself into various species of vegetables. In each vegetable it appears in one shape in the root, another in the stalk, another in the flowers, another in the seeds, &c. From hence various bodies proceed; from the oak, houses, ships, &c. from hemp and flax we have thread; from thence our various kinds of linen; from thence garments; these degenerate into rags, which receive from the mill the various forms of paper; hence our books.

According to Sir Isaac Newton, it

seems highly probable, that God in the beginning formed matter into solid, massy, impenetrable, moveable particles, or atoms, of such sizes and figures, and with such other properties, and in such proportion to space, as most conduced to the end for which he formed them; and that these primitive particles, being solids, are incomparably harder than any porous bodies compounded of them, even so hard as never to wear or break in pieces; no ordinary power being able to divide what God himself made one in the first creation. While these particles continue entire, they may compose bodies of one and the same nature and texture in all ages; but should they wear away, or break in pieces, the nature of things depending on them may be changed. Water and earth, composed of old worn particles and fragments of particles, would not be of the same nature and texture now, with water and earth composed of entire particles in the beginning; and therefore, that nature may be lasting, the changes of corporeal things are to be placed only in the various separations and new associations of motions of these permanent particles, compound bodies being apt to break, not in the midst of solid particles, but where these particles are laid together, and only touch in a few points.

Dr. Berkeley argues against the existence of matter itself; and endeavours to prove that it is a mere *ens rationis*, and has no existence out of the mind. Some late philosophers have advanced a new hypothesis concerning the nature and essential properties of matter.

The first of these who suggested, or at least published an account of this hypothesis, was M. Boscovich, in his "Theoria Philosophiæ Naturalis." He supposes, that matter is not impenetrable, but that it consists of physical points only, endued with powers of attraction and repulsion, taking place at different distances, that is, surrounded with various spheres of attraction and repulsion; in the same manner as solid matter is generally supposed to be. Provided, therefore, that any body move with a sufficient degree of velocity, or have sufficient momentum to overcome any power of repulsion that it may meet with, it will find no difficulty in making its way through any body whatever. If the velocity of such a body in motion be sufficiently great, Boscovich contends, that the particles of any body through which it passes, will not even be moved out of their place by it.

With a degree of velocity something less than this, they will be considerably agitated, and ignition might perhaps be the consequence, though the progress of the body in motion would not be sensibly interrupted; and with a still less momentum it might not pass at all. Mr. Mitchell, Dr. Priestley, and some others of our own country, are of the same opinion. See Priestley's "History of Discoveries relating to Light," p. 390. In conformity to this hypothesis, this author maintains, that matter is not that inert substance that it has been supposed to be; that powers of attraction or repulsion are necessary to its very being, and that no part of it appears to be impenetrable to other parts. Accordingly, he defines matter to be a substance, possessed of the property of extension, and of powers of attraction or repulsion, which are not distinct from matter, and foreign to it, as it has been generally imagined, but absolutely essential to its very nature and being: so that when bodies are divested of these powers, they become nothing at all. In another place, Dr. Priestley has given a somewhat different account of matter: according to which it is only a number of centres of attraction and repulsion; or more properly of centres, not divisible, to which divine agency is directed; and as sensation and thought are not incompatible with these powers, solidity, or impenetrability, and consequently a vis inertiæ only having been thought repugnant to them, he maintains, that we have no reason to suppose, that there are in man two substances absolutely distinct from each other. See "Disquisitions on Matter and Spirit."

But Dr. Price, in a correspondence with Dr. Priestley, published under the title of "A Free Discussion of the Doctrines of Materialism and Philosophical Necessity," 1778, has suggested a variety of unanswerable objections against this hypothesis of the penetrability of matter, and against the conclusions that are drawn from it. The vis inertiæ of matter, he says, is the foundation of all that is demonstrated by natural philosophers concerning the laws of the collision of bodies. This, in particular, is the foundation of Newton's philosophy, and especially of his three laws of motion. Solid matter has the power of acting on other matter by impulse; and this is the

only way in which it is capable of acting, by any action that is properly its own. If it be said, that one particle of matter can act upon another without contact and impulse, or that matter can, by its own proper agency, attract or repel other matter which is at a distance from it, then a maxim hitherto universally received must be false, that "nothing can act where it is not." Newton, in his letters to Bentley, calls the notion, that matter possesses an innate power of attraction, or that it can act upon matter at a distance, and attract and repel by its own agency, an absurdity, into which he thought no one could possibly fall. And in another place he expressly disclaims the notion of innate gravity, and has taken pains to shew that he did not take it to be an essential property of bodies. By the same kind of reasoning pursued, it must appear, that matter has not the power of attracting and repelling; that this power is the power of some foreign cause, acting upon matter according to stated laws; and, consequently, that attraction and repulsion, not being actions, much less inherent qualities of matter, as such it ought not to be defined by them. And if matter has no other property, as Dr. Priestley asserts, than the power of attracting and repelling, it must be a nonentity; because this is a property that cannot belong to it. Besides, all power is the power of something; and yet, if matter is nothing but this power, it must be the power of nothing; and the very idea of it is a contradiction.

MATTHIOLA, in botany, so named from Pietro Andrea Matthiolus, the famous botanist, a genus of the Pentandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character: calyx entire; corolla tubular, superior, undivided; drupe with a globular nucleus. There is but one species, *viz.* M. scabra, a native of America.

MATTUSCHKÆA, in botany, a genus of the Tetrandria Monogynia class and order. Essential character: calyx four-parted, with linear leaflets; corolla one-petalled, with a long tube and four cleft border; germ superior, four-cleft; seeds four, naked. There is but one species, *viz.* M. hirsuta, found in Guiana.

MAUNDY *Thursday*, is the Thursday in Passion Week, which was called Maunday or Mandate Thursday, from the command which our Saviour gave his apostles, to commemorate him in the Lord's Supper, which he this day instituted; or from the new commandment which he gave them, to love one another, after he had washed their feet as a token of his love to them. Our Saviour's humility in washing his disciples' feet, is commemorated on this day by most christian kings; who wash the feet of a certain number of poor people, not indeed with their own royal hands, but by the hands of their lord almoner, or some other deputy.

MAUPERTUIS (Peter Louis Morceau de), a celebrated French mathematician and philosopher, was born at St. Malo in 1698, and was there privately educated till he attained his sixteenth year, when he was placed under the celebrated professor of philosophy, M. Le Blond, in the college of La Marche, at Paris; while M. Guisnée, of the Academy of Sciences, was his instructor in mathematics.

For this science he soon discovered a strong inclination, and particularly for geometry. He likewise practised instrumental music, in his early years, with great success; but fixed on no profession till he was twenty, when he entered into the army; in which he remained about five years, during which time he pursued his mathematical studies with great vigour; and it was soon remarked by M. Freret, and other academicians, that nothing but mathematics could satisfy his active soul and unbounded thirst for knowledge.

In the year 1723, he was received into the Royal Academy of Sciences, and read his first performance, which was a memoir upon the construction and form of musical instruments. During the first years of his admission, he did not wholly confine his attention to mathematics; he dipped into natural philosophy, and discovered great knowledge and dexterity in observations and experiments upon animals.

If the custom of travelling into remote countries, like the sages of antiquity, in order to be initiated into the learned mysteries of those times, had still subsisted, no one would have conformed to it with more eagerness than Maupertuis. His first gratification of this passion was to visit the country which had given birth to Newton; and during his residence at London he became as zealous an admirer and follower of that philosopher as any of his own countrymen. His next excursion was to Basil in Switzerland, where he formed a friendship with the celebrat-

ed John Bernoulli and his family, which continued till his death. At his return to Paris, he applied himself to his favourite studies with greater zeal than ever. And how well he fulfilled the duties of an academician, may be seen by running over the memoirs of the academy from the year 1724 to 1744; where it appears he was neither idle, nor occupied by objects of small importance. The most sublime questions in the mathematical sciences, received from his hand that elegance, clearness, and precision, so remarkable in all his writings.

In the year 1736, he was sent to the polar circle, to measure a degree of the meridian, in order to ascertain the figure of the earth; in which expedition he was accompanied by Messrs. Clairault, Camus, Monnier, Outhier, and Celsus, the celebrated professor of astronomy at Upsal. This business rendered him so famous, that on his return he was admitted a member of almost every academy in Europe.

In the year 1740, Maupertuis had an invitation from the King of Prussia to go to Berlin; which was too flattering to be refused. His rank among men of letters had not wholly effaced his love for his profession, that of arms. He followed the King to the field, but at the battle of Molwitz was deprived of the pleasure of being present, when victory declared in favour of his royal patron, by a singular kind of adventure. His horse during the heat of the action running away with him, he fell into the hands of the enemy; and was at first but roughly treated by the Austrian Hussars, to whom he could not make himself known for want of language; but being carried prisoner to Vienna, he received such honours from the Emperor as never were effaced from his memory. Maupertuis lamented very much the loss of a watch of Mr. Graham's, the celebrated English artist, which they had taken from him; the Emperor, who happened to have another by the same artist, but enriched with diamonds, presented it to him, saying, "The Hussars meant only to jest with you, they have sent me your watch, and I return it to you."

He went soon after to Berlin, but as the reform of the academy which the King of Prussia then meditated was not yet mature, he repaired to Paris, where his affairs called him, and was chosen, in 1742, director of the Academy of Sciences. In 1743, he was received into the French Academy, which was the first instance of the same person being a member of both the academies at Paris at the same time. Maupertuis again assumed the soldier at the siege of Fribourg, and was pitched upon by Marshal Coigny and the Count d'Argenson, to carry the news to the French King of the surrender of that citadel.

Maupertuis returned to Berlin in the year 1744, when a marriage was negotiated and brought about, by the good offices of the Queen mother, between our author and Mademoiselle de Borck, a lady of great beauty and merit, and nearly related to M. de Borck, at that time minister of state. This determined him to settle at Berlin, as he was extremely attached to his new spouse, and regarded this alliance as the most fortunate circumstance of his life.

In the year 1746, Maupertuis was declared, by the King of Prussia, president of the Royal Academy of Sciences at Berlin, and soon after by the same prince was honoured with the Order of Merit. However, all these accumulated honours and advantages, so far from lessening his ardour for the sciences, seemed to furnish new allurements to labour and application. Not a day passed but he produced some new project or essay for the advancement of knowledge. Nor did he confine himself to mathematical studies only; metaphysics, chemistry, botany, polite literature, all shared his attention, and contributed to his fame. At the same time he had, it seems, a strange inquietude of spirit, with a dark atrabilaire humour, which rendered him miserable amidst honours and pleasures. Such a temperament did not promise a pacific life; and he was in fact engaged in several quarrels. One of these was with Kœnig, the professor of philosophy at Franeker, and another more terrible with Voltaire. Maupertuis had inserted in the volume of memoirs of the academy of Berlin for 1746, a discourse upon the laws of motion; which Kœnig was not content with attacking, but attributed to Leibnitz. Maupertuis, stung with the imputation of plagiarism, engaged the academy of Berlin to call upon him for his proof; which Kœnig failing to produce, his name was struck out of the academy, of which he was a member.

Several pamphlets were the consequence of this measure; and Voltaire, for some reason or other, engaged in the quarrel against Maupertuis. We say, for some reason or other, because Maupertuis and Voltaire were apparently upon

the most amicable terms; and the latter respected the former as his master in the mathematics. Voltaire, upon this occasion, exerted all his wit and satire against him; and upon the whole was so much transported beyond what was thought right, that he found it expedient, in 1753, to quit the court of Prussia.

Our philosopher's constitution had long been considerably impaired by the great fatigues of various kinds in which his active mind had involved him; though, from the amazing hardships he had undergone, in his northern expedition, most of his bodily sufferings may be traced. The intense sharpness of the air could only be supported by means of strong liquors, which helped but to lacerate his lungs, and to bring on a spitting of blood, which began at least twelve years before he died. Yet still his mind seemed to enjoy the greatest vigour; for the best of his writings were produced, and most sublime ideas developed, during the time of his confinement by sickness, when he was unable to occupy his presidial chair at the academy. He took several journies to St Malo, during the last years of his life, for the recovery of his health; and though he always received benefit by breathing his native air, yet still, upon his return to Berlin, his disorder likewise returned with greater violence.

His last journey into France was undertaken in the year 1757; when he was obliged, soon after his arrival there, to quit his favourite retreat at St. Malo, on account of the danger and confusion which that town was thrown into by the arrival of the English in its neighbourhood. From thence he went to Bourdeaux, hoping there to meet with a neutral ship to carry him to Hamburgh, in his way back to Berlin; but being disappointed in that hope, he went to Toulouse, where he remained seven months. He had then thoughts of going to Italy, in hopes a milder climate would restore him to health; but finding himself grow worse, he rather inclined towards Germany, and went to Neufchatel, where for three months he enjoyed the conversation of Lord Marischal, with whom he had formerly been much connected. At length he arrived at Basil, Oct. 16, 1758, where he was received by his friend Bernoulli and his family with the utmost tenderness and affection. He at first found himself much better here than he had been at Neufchatel; but this amendment was of short duration; for as the winter approached his disorder returned, accompanied by new and more alarming symptoms. He languished here many months, during which he was attended by M. de la Condamine, and died in 1759, at 61 years of age.

The works which he published were collected into 4 vols. 8vo. published at Lyons in 1756, where also a new and elegant edition was printed in 1768. These contain the following works: 1. Essay on Cosmology.—2. Discourse on the different Figures of the Stars.—3. Essay on Moral Philosophy.—4 Philosophical Reflections upon the Origin of Languages, and the Signification of Words.—5. Animal Physics, concerning Generation, &c.—6. System of Nature, or the Formation of Bodies.—7. Letters on various Subjects.—8. On the Progress of the Sciences.—9. Elements of Geography.—10. Account of the Expedition to the Polar Circle, for determining the Figure of the Earth; or the Measure of the Earth at the Polar Circle.—11. Account of a Journey into the Heart of Lapland, to search for an ancient Monument.—12. On the Comet of 1742.—13. Various Academical Discourses, pronounced in the French and Prussian Academies.—14. Dissertation upon Languages.—15. Agreement of the different Laws of Nature, which have hitherto appeared incompatible.—16. Upon the Laws of Motion.—17. Upon the Laws of Rest.—18. Nautical Astronomy.—19. On the Parallax of the Moon.—20. Operations for determining the Figure of the Earth, and the Variations of Gravity.—21. Measure of a Degree of the Meridian at the Polar Circle.

Besides these works, Maupertuis was author of a great multitude of interesting papers, particularly those printed in the Memoirs of the Paris and Berlin Academies, far too numerous here to mention, *viz.* in the Memoirs of the Academy at Paris from the year 1724 to 1749; and in those of the Academy of Berlin, from the year 1746 to 1756.

MAURITIA, in botany, belonging to the App. Palmæ, and natural order of Palms. Essential character: male in an oblong sessile ament; calyx one-leafed, cup-shaped, entire; corolla one-petalled, with a short tube, and a three-parted border; filaments six. There is but one species, *viz.* M. flexuosa, a native of the woods of Surinam.

MAXILLA, the jaws, or those parts of an animal in which the teeth are set.

MAXIM, an established proposition or

principle, in which sense it denotes much the same with axiom. See Axiom.

Maxims are a kind of propositions, which have passed for principles of science, and which, being self-evident, have been by some supposed innate.

MAXIMUM, in mathematics, denotes the greatest state or quantity attainable in a given case, or the greatest value of a variable quantity; hence it stands opposed to the minimum, which is the least possible quantity in any case. Thus in the expression $a^2 - b\,x$, where a and b are constant, and x variable, the value of the expression will increase as $b\,x$ or x diminishes, and it will be greatest, or a maximum, when x is least, or $=0$. The expression $a^2 - \frac{b}{x}$ increases as $\frac{b}{x}$ diminishes, that is, as x increases, and it will be a maximum when x is infinite. If along the diameter, K Z (Plate X. Miscel. fig. 4.) of a circle, a perpendicular ordinate, L M, be conceived to move from K to Z, it increases till it arrive at the centre, where it is greatest, and from thence it decreases till it vanishes at Z. Some quantities continually increase, and have no maximum, unless what is infinite, as the ordinates of a parabola: some continually decrease, so that their minimum state is nothing, as the ordinates to the asymptotes of the hyperbola. Others increase to a certain point, which is their maximum, and then decrease again; as the ordinates of a circle. Others admit of several maxima and minima; as the ordinates of the curve (fig. 5) $a\,b\,c\,d\,e$, &c. where b and d are the maxima, and $a\,c\,e$ are minima: hence it is easy to imagine of other variable quantities, exhibited by the ordinates of other kinds of curves. We have, under the article Fluxions, given some examples on the maxima and minima of quantities: we shall in this place point out another mode of performing the same thing, with an example or two. The rule is this: "Find two values of an ordinate expressed in terms of the abscissa: put those two values equal to each other, striking out the parts that are common to both, and dividing all the remaining terms by the difference between the abscissas, which will be a common factor in them: then supposing the abscissas to become equal, that the equal ordinates may concur in the maximum or minimum, that difference will vanish, as well as all the terms of the equation that include it, and therefore, striking those terms out of the equation, the remaining terms will give the value of the abscissa corresponding to the maximum."

1. Suppose it were required to find the greatest ordinate in a semicircle K M Q Z. Let $KZ = a$: K L the abscissa $= x$: L M the ordinate $= y$: hence $LZ = a - x$, and by the nature of the circle $KL \times LZ = LM^2$, that is $a\,x - x^2 = y^2$,

Let the abscissa $KP = x \times d$, d being equal to L P; the ordinate $PQ = LM = y$. $KP \times PZ = PQ^2$, or $\overline{x + d} \times \overline{a - x - d} = a\,x - x^2 - 2\,d\,x + a\,d - d^2 = y^2 = a\,x - x^2$; therefore $-2\,d\,x + a\,d - d^2 = 0$: or $a\,d = 2\,d\,x + d^2$, or $a = 2\,x + d$, an equation derived from the equality of the two ordinates: now, by bringing the two equal ordinates together, or making the two abscissas equal, their difference, d, vanishes, and $a = 2\,x$, or $x = \frac{a}{2} = $ K N, the value of the abscissa K N, when N O is a maximum, that is, the greatest ordinate bisects the diameter.

2. Let it be required to divide a given line into two such parts, that the one drawn into the square of the other may be the greatest possible. Let the given line be a; one part x, of course the other part $a - x$; and therefore by the terms of the question $x^2 \times \overline{a - x} = a\,x^2 - x^3$ is the product of one part by the square of the other. For the sake of comparison, let one part be $x + d$, then the other part will be $a - x - d$ and $\overline{x + d}^2 \times \overline{a - x - d} = a\,x^2 - x^3 - 3\,d\,x^2 + \overline{2\,a\,d - 3\,d^2} \times x + a\,d^2 - d^3 =$ (as before) $a\,x^2 - x^3$; therefore, $-3\,d\,x^2 + \overline{2\,a\,d - 3\,d^2} \times x + a\,d^2 - d3$, divided by d, gives $-3\,x^2 + \overline{2\,a - 3\,d} \times x + a\,d - d^2$, and now striking out the terms that have d in them, we get $-3\,x^2 + 2\,a\,x = 0$, and $3\,x = 2\,a$, and $x = \frac{2}{3}a$, that is, the given line must be divided into two parts, in the ratio of 3 to 2.

MAXIMUS (Tyrius), in biography, a celebrated philosopher and elegant writer in the second century, was a native of Tyre, in Phœnicia, whence he took his name. Suidas says, that he lived under the Emperor Commodus, while Eusebius and Syncellus place him under Antoninus Pius. If we suppose that he flourished under Antoninus, and lived to the time of the first mentioned Emperor, the accounts of those chronologers may be reconciled. According to some writers, he came to Rome in the year 146, where the Emperor

Marcus Aurelius gave him many tokens of his esteem, and placed himself under his instruction; but it is more probable, that the preceptor of whom that prince speaks, under the name of Maximus, was some other philosopher, of the Stoical sect. Our Maximus appears, from his writings, to have adopted the principles of the Platonic school, with some tendency towards scepticism. Forty-one of his "Dissertations" on various philosophical topics are still extant, and display the most captivating powers of eloquence. The first Latin version of them was published at Basil, by Cosmo Pazzi, Archbishop of Florence, in 1519, folio; and Henry Stevens first printed the original Greek, at Paris, in 1557, 8vo. to which he added Pazzi's version, with numerous alterations and corrections. In 1607, the learned Daniel Heinsius published an edition of them at Leyden, in Greek and Latin, 8vo.; the version being his own, and illustrated with notes. Of this edition our countryman, Dr. John Davies, gave a new impression from the Cambridge press, in 1703, 8vo. with corrections, additional notes, and two useful indexes.

MAYER (TOBIAS), in biography, a very able German astronomer and mechanic in the eighteenth century, was born at Marspach, in the duchy of Wirtemberg, in the year 1723. His father was an ingenious civil-engineer, who particularly excelled in hydraulics; and young Tobias, who was fond of observing him while at work, displayed an early inquisitiveness concerning such ingenious pursuits, and from the age of four years began to design machines with the greatest dexterity and justness. The death of his father, however, whom he lost when very young, probably prevented him from being educated to that employment. Possessing but scanty means for obtaining assistance in his studies, he was obliged to rely on his own energies, by which he made himself a proficient in mathematical learning, and became qualified to be an able instructor of others. While thus occupied, he also assiduously cultivated an acquaintance with classical and polite literature, and learned to write the Latin tongue with elegance. So well established was his reputation when he had attained to his eight-and-twentieth year, that the university of Gottingen nominated him to the chair of mathematical professor; and not long afterwards he was admitted a member of the Royal Society in that town. From this time, every year of his short, but glorious life, was distinguished by some considerable discoveries in geometry or astronomy. He invented several useful instruments for the more commodious and exact measurement of angles on a plane. He corrected many errors in practical geometry, tracing them to their origin, in the refractions occasioned by terrestrial objects. Afterwards he particularly applied himself to study the theory of the moon, its appearances, the question of its atmosphere, and the reciprocal actions of the sun, earth, and moon, upon each other. He then extended his observations to the planet Mars, and the fixed stars; determining with greater exactness than before the places of the latter, and ascertaining that, though commonly denominated fixed, they possess a certain degree of motion relative to their respective systems. Towards the end of his life the magnetic needle engaged his attention, to which he assigned more certain laws than those before received. To these various inquiries and observations he applied with such indefatigable assiduity, that he died, exhausted and worn out by his labours, in 1762, when only 39 years of age. His table of refractions, deduced from his astronomical observations, agrees very nicely with that of Dr. Bradley; and his theory of the moon, and astronomical tables and precepts, were so well received, that they were rewarded by the English Board of Longitude with the premium of 3,000*l.* which sum was paid to his widow after his decease. These tables and precepts were published by the board in the year 1770. The principal works which he gave himself to the public were, "A New and General Method of resolving all Geometrical Problems, by means of Geometrical Lines," 1741, 8vo. in German. "A Mathematical Atlas, in which all the Mathematical Sciences are comprised in sixty Tables," 1748, folio, in German. "A Description of a Lunar Globe, constructed by the Cosmographical Society of Nuremberg, from new Observations," 1750, 4to. also in German. Several exact "Maps;" and some valuable papers in the Memoirs of the Royal Society of Gottingen. The first volume of his works was published at that place in 1775, in folio.

MAYOR, is the chief magistrate in a city or town corporate, who has under him aldermen, common-council, and officers of different kinds. Their authority is different, according to different charters; but they are always magistrates within the corporation.

MEAN, a middle state between two extremes; thus we have an arithmetical mean, geometrical mean, mean distance, mean motion, &c. An arithmetical mean is half the sum of the extremes: thus, if 2 and 12 be the extremes, then $\frac{2+12}{2}=7$ is the arithmetical mean: likewise between a and b it is $\frac{a+b}{2}$. Geometrical mean, usually called a mean proportional, is the square root of the product of the two extremes: therefore, to find a mean proportional between two given extremes, multiply these together, and extract the square root of the product. Thus, a mean proportional between 6 and 24 is 12; for $\sqrt{6 \times 24} = \sqrt{144} = 12$: and between x and y it is $\sqrt{xy}$. The arithmetical mean is greater than the geometrical mean between the same two extremes: thus, between 6 and 24 the geometrical mean is 12; but the arithmetical mean is $\frac{6+24}{2} = 15$. Or, generally, let a be the greater and b the less; then $\frac{a+b}{2}$ is greater than $\sqrt{ab}$, or multiplying both by 2; $a+b$ is greater 2 $\sqrt{ab}$: for squaring both we have $a^2 + 2ab + b^2$ greater than $4ab$; for take away $4ab$ and $a^2 - 2ab + b^2$ greater than 0: or $\overline{a-b}|^2$ greater than 0 by the supposition.

To find a mean proportional, geometrically, between two given right lines, a and b, (Plate Miscel. X. fig. 6.) join the two given lines together at x in one continued line, ab; upon the diameter ab describe a semicircle azb, and erect the perpendicular zx, which will be the required mean proportional; for, by a well-known theorem in geometry, $ax \times xb$ is equal to xz^2, or $ax : xz :: xz : xb$.

To find two mean proportionals between two given extremes: "Multiply each extreme by the square of the other, *viz.* the greater extreme by the square of the less, and the less extreme by the square of the greater; then extract the cube root out of each product, and the two roots will be the two mean proportionals sought. Thus the two mean proportionals between a and b are $\sqrt[3]{a^2 b}$ and $\sqrt{ab^2}$: or between 2 and 16 the mean proportionals are $\sqrt[3]{64}$, and $\sqrt[3]{512} = 4$ and 8.

MEAN *harmonical*. See HARMONICAL *proportion*.

MEAN *distance of a planet from the sun*, in astronomy, is the right line drawn from the sun to the extremity of the conjugate axis of the ellipsis the planet moves in; and this is equal to the semi-transverse axis, and is so called, because it is a mean between the planet's greatest and least distance from the sun. See DISTANCE.

MEAN *motion*, in astronomy, that whereby a planet is supposed to move equally in its orbit, and is always proportional to the time. See MOTION.

MEASLES. See MEDICINE.

MEASURE signifies any given quantity, estimated as one, to which the proportion of other similar quantities may be expressed.

Measure is classed under a variety of heads, of which the following are illustrations.

MEASURE *of velocity*, is the interval of space between two points, regularly passed through by a substance in constant and uniform motion, within a certain period of time.

MEASURE *of a solid*, is a cubic inch, foot, or yard; in other words, a cube, the side of which is an inch, a foot, or a yard.

MEASURE *of a line*, is the extension of a right line at pleasure, which is to be considered as unity; for instance, an inch, a foot, or a yard.

MEASURE *of a figure*, or a surface perfectly level, thence called a plane surface, is a square inch, foot, or yard. This square is termed the measuring unit, because the side is an inch, a foot, a yard, or any other determinate extent.

MEASURE *of a certain portion or quantity of matter*, is its weight.

MEASURE *of a number*, applies thus: 2 is the measure of 4, 3 of 6, &c.; in fact, it is any number which divides without a remainder.

It has long been wished by the learned, that an universal measure, secured by penalties in an unalterable state, had hitherto been, or may hereafter be adopted, which would prove of incalculable advantage to mankind in their philosophical and even less exalted pursuits. Prejudices are, however, far too numerous and powerful to be easily overcome, or removed, in matters of infinitely less moment. We cannot, therefore, entertain the slightest hope that national partiality will be subdued in every quarter of the globe, so as to produce a general resignation of favourite methods, in order to adopt a new one recommended by a congress of philosophers, which it would be

equally difficult to assemble, or prevail upon to agree to any plan unanimously. The theories of eminent men on this subject are useful and deserve attention, as they may suggest improvements of great importance. Huygens proposed the length of a pendulum that should vibrate seconds, to be measured from the point of suspension to that of oscillation. The third part of this pendulum he termed a horary foot, and such he recommended should be the standard by which the measure of every foot in Europe might be regulated. Admitting his plan to be worthy of adoption, and an experiment made, it appears that the Paris foot would bear a proportion to the horary foot of 864 to 881, which is demonstrated in this manner: The length of three Paris feet is 864 half lines, and that of a pendulum vibrating seconds consists of 881 half lines. The principal objection to this ingenious suggestion of Huygens is founded on the assumption, that the action of gravity is the same in all parts of the globe, which is certainly not the case; consequently, instead of its serving universally, it would be useful only in those places which lie under the same parallel of latitude. Thus, if each different latitude had its foot equal to the proposed third part of the pendulum vibrating seconds there, any given latitude must have a different length for the foot. Exclusive of this objection, there would be a second proceeding from the difficulty attending the exact measurement between the centres of motion and oscillation, which is such, that it is highly probable no two persons would agree in their accounts of the space.

Many attempts and expedients were suggested, after the rejection of the above plan, with similar want of success. This circumstance did not escape the notice of the Society for the Encouragement of Arts, Manufactures, and Commerce, the officers of which, with a commendable zeal, advertized a premium of one hundred guineas, or a gold medal, as a reward to those who would propose the approved means "for obtaining invariable standards for weights and measures, communicable at all times and to all nations." This invitation produced a communication from Mr. Hatton, in 1779, in which he proposed the application of a moveable point of suspension to one and the same pendulum, and by this means he intended to accomplish the full effect of two, the difference in the lengths of which was the desired measure.

The ideas of Mr. Hatton were approved by the ingenious Whitehurst, who improved upon them, and invented some very curious and excellent machinery; besides which, he published, eight years after, a work entitled "An Attempt towards obtaining invariable Measures of Length, Capacity, and Weight, from the Mensuration of Time," &c. Mr. Whitehurst thought it convenient and proper, for attaining this most desirable end, to endeavour to obtain a measure of the greatest convenient length from two pendulums, the vibrations of which are in the ratio of two to one, and of lengths agreeing with the English standard in whole numbers.

To explain our philosopher's intentions more fully, let us admit the supposition, that the length of a pendulum vibrating seconds in the latitude of London is 39.2 inches; the length of one vibrating 42 times in a minute amounts to 80 inches; by the same unerring rule, another vibrating 84 times in a minute must be 20 inches: the difference resulting from these data is 60 inches and his proposed standard measure. Pursuing his experiments to the very acme of perfection, he found the variation in the length of the two pendulums to be 59.892 inches, instead of 60, arising from an error in the assumed length of the second's pendulum.

It is generally admitted, that Mr. Whitehurst has succeeded in his design, and demonstrated to the learned how an invariable standard may at any time be found for the same latitude. Besides this discovery, the world is indebted to him for the accurate ascertaining of a fact of very considerable importance in natural philosophy. A person who wrote with ability on this point observes, with respect to the fact just mentioned, "The difference between the lengths of the rods of two pendulums, whose vibrations are known, is a datum from which may be derived the true lengths of pendulums, the spaces through which heavy bodies fall in a given time, with many other particulars relative to the doctrine of gravitation, the figure of the earth," &c. Mr. Whitehurst perceived from this experiment, that the length of a second's pendulum, vibrating in a circular arc of 3° 20′, is very nearly 39.119; but performing the same motion in the arc of a cycloid, the result would be 39.136 inches; consequently, weighty substances will descend in the first second after they are detached from their support nearly 16.094 feet, or 16.1⅛ inch.

Dr. Young, to whom we acknowledge ourselves indebted for many of the following particulars, has given an excellent compressed table of measures and standards, in his recent valuable work, "A Course of Lectures on Natural Philosophy," &c. from which we find, that the English yard is said to have been derived from the length of the arm of Henry I. in the year 1101; that Graham asserts the length of the pendulum vibrating seconds accurately is equal to 39.13 inches; that Bird's parliamentary standard is admitted to be of the greatest authority, and that it agrees nearly with the scales of Shuckburgh and Pictet, made by Troughton. The standard of the Royal Society by Graham exceeds that of Bird's in length about 1000th part of an inch, but it is not quite uniform throughout its length. The standard in the Exchequer is about .0075 inch shorter than the yard of the Royal Society. General Roy used a scale of Sisson, divided by Bird, and found it to agree exactly with the Tower standard on the Royal Society's scale. Sir George Shuckburgh, adopting Troughton's scales for the standard, found the original Tower standard 36.004; the yard E. on the Royal Society's scale by Graham 36.0013 inches; the yard Exchequer of the same scale 35.9933; Roy's scale 36.00036; the Royal Society's scale by Bird 35.99955; Bird's parliamentary standard of 1758, 36.00023. The English have employed and adjusted their standards at the temperature of 62° of Fahrenheit's thermometer, and the French at the freezing point of water. The French metre is 39.37100 English inches, and the ten millionth part of the quadrant of the meridian. The same measure contains 36.9413 French inches, or three feet 11.296 lines. Hence, says the Doctor, the French toise of 72 inches is equal to 76.736 English inches. One of Lalande's standards measured by Dr. Maskelyne was 76.732, the other 76.736. In latitude 45°, a pendulum of the length of a metre would perform in a vacuum 86116.5 vibrations in a day. The length of the second pendulum is 993827 at Paris.

The French National Institute of Sciences and Arts have turned their attention to this subject, and in the month of Nivose, in the year 1801, a member read a report from a committee, founded on the comparison of the standard metre of the Institute with the English foot. And M. Pictet, professor of natural philosophy at Geneva, exhibited to the class, in the month of Vendemiaire, a collection of the most interesting objects, which he had collected in England, relating to arts and sciences. One of the number was a standard of the English linear measure, which was of brass, 49 inches in length, and neatly divided by engraved lines into tenths of an inch. This standard was made for the exhibitor by Troughton, a resident in London, who has deservedly acquired the reputation of dividing instruments with the utmost accuracy, which was compared with another made by the same artist for Sir George Shuckburgh, when it was ascertained, satisfactorily, that the variations between them did not amount to more than the difference between the divisions of each; in other words, the variation was almost imperceptible. Arguing from this circumstance, the standard may be considered as identical with that described by Sir George Shuckburgh in the Philosophical Transactions for 1798.

Another excellent instrument, constructed by Mr. Troughton, and shewn at the same time by M. Pictet, was a comparer, calculated to ascertain minute variations between measures. This instrument "consists of two microscopes, with cross wires, placed in a vertical situation, the surface of the scale being horizontal, and fixed at proper distances upon a metallic rod. One of them remains stationary at one end of the scale, the other is occasionally fixed near to the other end; and its cross wires are moveable by means of a screw, describing in its revolution one 100th part of an inch, and furnished with a circular index, dividing each turn into 100 parts; so that having two lengths, which differ only one-tenth of an inch from each other, we may determine their difference in ten-thousandths of an inch. The wires are placed obliquely with respect to the scale, so that the line of division must bisect the acute angle which they form, in order to coincide with their intersection." An instrument similar to that thus described, and made by Ramsden, for measuring the expansion of metals, was described by General Roy in the seventy-fifth volume of the Royal Transactions.

M. Pictet, influenced by a desire of advancing science, made an offer to the class of the use of the standard and the micrometer, for the purpose of determining the comparative length of the metre and the English foot: the offer was gratefully accepted by the Society, and Messieurs Legendre, Machain, and Prony, were appointed to assist M. Pictet in making the

proposed comparison of their standard metre of platina and the measure just mentioned. The first assembling of this committee was on the 21st of October, of the same year, at the mansion of M. Lenoir. Upon commencing their operations, they found some difficulty arising from the different manner in which the measures were defined: the French standards were merely cut off to the length of a metre; but the English scale was graduated by lines; consequently, the length of the former could not readily be taken by the microscopes, neither could the English scale be measured by the usual method adopted for making new standard metres, which is accomplished by fixing one extremity against a firm support, "and bringing the other into contact with the face of a cock, or slider, adjusted so as barely to admit the original standard between it and the fixed surface."

M. Lenoir endeavoured to remove this unfortunate impediment, by taking a piece of brass of the length of a metre, and reducing the terminations to a thin edge, which was compared by the committee with the standard metre as usual; when placed on the English scale, the extremities of the brass made two parallel lines to those engraved on the scale, and thus the apparatus was capable of being seen through the microscope: by these means the standard metre of platina, and another belonging to the Institute, made of iron, were compared with the English foot; the two measures each being equal, at the temperature of melting ice, to the ten millionth part of the quadrant of the meridian. "At the temperature of 15.3° of the decimal thermometer, or 59.5° of Fahrenheit, the metre of platina was equal to 39.3775 English inches, and that of iron to 39.3788, measured on M. Pictet's scale.

It was discovered, however, that the manner employed produced results not quite satisfactory, as an uncertainty occurred through the difficulty of placing the cross wires exactly at the extreme of the brass plate, where a reflection of light took place which precluded a distinct observation, whether the optical axis of the microscope was decidedly a tangent to the surface precisely at the termination. M. Prony, a member of the committee, suggested another arrangement as a remedy for this obstacle, and M. Paul, of Geneva, who was present, carried it into execution: this latter gentleman traced a perpendicular line to its length, on a small metallic ruler, the end of which he placed against a firm resistance, and the cross wires were made to agree with the line; they then interposed the standard metre between the end of the piece and the resisting substance, "and the line traced on it, which had now obviously advanced the length of the metre, was subjected to the other microscope. The microscopes, thus fixed, were transferred to the graduated scale; one of them was placed exactly over one of the divisions, and the micrometer screw was turned in order to measure the fraction, expressing the distance of the other microscope from another division."

A second comparison took place on the 26th of October, at the residence of a member of the committee; and after several satisfactory experiments, it was discovered, that at the temperature 12.75°, or 55 of Fahrenheit, the standard of platina was 39.3781, and that of iron 39.3795 English inches. The different metres being intended to be equal at the temperature of melting ice, the preceding experiments may be tried by bringing their results to the same temperature. To determine this, we have Borda's accurate trials, and the report of the committee of weights and measures on the dilatation of platina, brass, and iron, whence it appears, "that for each degree of the decimal thermometer, platina expands .00000856; iron, 00001156; and brass, 00001783: for Fahrenheit's scale these quantities become 476; 642, and 990 parts in a hundred millions. From these data we find, that, at the freezing point, the standard metre of platina was equal to 39.38280, and that of iron to 39.38265 English inches of M. Pictet's scale. The difference is less than the 500th of a line, or the 200,000th of the whole metre."

The facts obtained by all the comparisons amount to this conclusion, taking each of the measures at the temperature of melting ice, the individual standard metres are equal to the 10,000,000th part of the quadrant of the meridian, and to 39.38272 English inches of M. Pictet's scale.

It is found, upon examination of the reduction of the standards of platina and iron to the freezing point, that they vary rather less than is asserted in the report, and that they agree "within a unit in the last place of the decimals expressing their magnitudes, or one ten thousandth of an inch." At the freezing point, the standard of platina becomes equal to 39.37380, and that of iron to 39.37370 English inches on

the scale of brass at 55°, and the mean of these to 39.37100 English inches at 62°, the temperature constantly adopted in the comparison of English standards, and particularly in the recent trigonometrical operations. This result corresponds in a most surprising manner with Mr. Bird's determination of the lengths of the toises sent to Dr. Maskelyne by M. Lalande, the mean of which was 76.734 inches, consequently the metre having been proved to contain 36.9413 French inches, appears to be equal to 39.3702 English inches, or rather either 39.3694 or 39.3710; as either of the two toises may have been more correct than the other, it will therefore be perfectly safe to give the preference to that measuring 76.726 inches.

Admitting the French measurements of the arc of the meridian to be correct, the complete circumference of the globe amounts to 24855.43 English miles, and its mean diameter 7911.73.

The nineteenth volume of the Bibliothéque Britannique contains a description of Lenoir's comparer, written by M. Prony. "Its peculiarity," according to Dr. Young, "consists in the application of a bent lever, of which the shorter arm is pressed against the end of the substance to be measured, while the longer serves as an index, carrying a vernier, and pointing out on a graduated arch the divisions of a scale, which by this contrivance is considerably extended in magnitude." It does not appear, at first sight, to be certain, "that the difficulty of fixing the axis of the lever with perfect accuracy, and of forming a curve for the surface of the shorter arm, or of reducing the gradation of the arc to equal parts of the right line in the direction of the substance to be measured, might not in practice more than counterbalance the advantage of this mechanical amplification of the scale over the simpler optical method employed in the English instruments."

We shall conclude this article by giving the following useful tables, compressed from the work already mentioned, as the most recent and valuable authority.

ENGLISH MEASURES.

	Inches.
A foot is	12
A yard	36
A pole, or rod	198
A furlong	7920
A mile	63360
A link	7 92
A chain	792
A nail of cloth	$2\frac{1}{4}$
A quarter	9
A yard	36
An ell	45
A hand	4
	Square yards.
An acre	4840

The wine gallon is fixed at 231 cubic inches, by an act passed in the reign of Queen Anne, consequently,

	Cubic Inches.
A pint is	28.875
A quart	57.75
A barrel	7276.5
A hogshead	14553.
A pint of country ale, or beer measure, is	35.25
A quart	70.5
A gallon	282.
A barrel, beer measure, is	10152.
——— ale ditto	9024.
——— country ditto	9588.
A hogshead, beer measure, is	15228.
——— ale ditto	13336.
——— country ditto	14382.
A pint, dry measure, is	33.6
A quart	67.2
A pottle	134.4
A gallon	268.8
A peck	537.6
A Winchester bushel	2150.42
A heaped bushel is one-third more.	
A quarter	17203.36

A wey, or load, is five quarters; and two loads make a last of wheat.

Sixty pounds is the mean weight of a bushel of wheat, 50 of barley, and 38 of oats.

Thirty-six heaped bushels make a chaldron of coals, which generally weigh about 2988 pounds.

An inch pipe, ten yards in length, contains precisely an ale gallon, weighing $10\frac{2}{9}$ pounds.

The ancient standard wine gallon of Guildhall contains 224 cubic inches.

It is imagined, that previous to the "Conquest, a cubic foot of water weighed 1000 ounces; 82 cubic feet weighed 2000 pounds, or a tun; that the same quantity was a tun of liquids; and a hogshead 8 cubic feet, or 13824 cubic inches, one 63d of which was 219.4 inches, or a gallon."

A quarter of a ton was a quarter of wheat, which weighed about 500 pounds; one eighth of this, or a bushel, was equivalent to a cubic foot of water. A chaldron of coals weighed 2000 pounds, and was a ton.

The French, acting upon a general sys-

tem of innovation during the late Revolution in that country, formed new measures, the nomenclature of which is generally disapproved of by the learned of England, and Dr. Young ventures to give them, in some degree amended, as follow:

	English inches.
Millometre	.03937
Centimetre	.39371
Decimetre	3.93710
Metre	39.37100
Decametre	393.71000
Hecatometre . . .	3937.10000
Chiliometre . . .	39371.00000
Myriometre . . .	393710.00000

The metre is 1.09364 yards, or nearly 1 yard, 1½ nail, or 443.2959 lines French, or .513074 toises.

A decametre is 10 yards, 2 feet, 9.7 inches.

A hecatometre, 109 yards, 1 foot, 1 inch.

A chiliometre, 4 furlongs, 213 yards, 1 foot, 10.2 inches.

A micrometre, 6 miles, 1 furlong, 156 yards, 6 inches.

Eight chiliometres are nearly 5 miles.

An inch is .0254 metre; 2441 inches, 62 metres; 1000 feet, nearly 305 metres.

An arc, a square decametre, is 3,95 perches.

A hecatre, 2 acres, 1 rood, 35.4 perches.

	Cubic inches English.
Millilitre	.06103
Centilitre	.61028
Decilitre	6.10280
Litre, a cubic decimitre	61.02800
Decalitre	610.28000
Hecatolitre	6102.80000
Chiliolitre	61028.00000
Myriolitre	610280.00000

Two and $\frac{1}{8}$th wine pints are about a litre; 3 wine pints are nearly 14 decilitres; a chiliolitre is one tun, 12.75 wine gallons.

3.5317 cubic feet make a decistere, a measure for fire-wood.

A sterc, a cubic metre, 35.3171.

We shall now present the reader of this article with various ancient and modern measures, which were selected from the best authorities.

ANCIENT MEASURES.

Arabian foot	1.095
Egyptian foot	1.421
Egyptian stadium	730.8
Greek foot	1.009
—— phyletarian foot	1.167
Hebrew foot	1.212
—— cubit	1.817
—— sacred cubit	2.002
—— great cubit=six common cubits.	
Natural foot	.814
Roman foot	.970
—— . . (after Titus)	.965
—— . . (from rules)	.9672
—— (from buildings)	.9681
—— . (from a stone)	.9696
Roman mile of Pliny	4840.5
—— of Strabo	4903.
Sicilian foot of Archimedes . .	.730

MODERN MEASURES.

Amsterdam foot	.927
—— ell	2.233
Antwerp foot	.940
Barcelona foot	.992
Basle foot	.944
Bavarian foot	.968
Berlin foot	.992
Bologna foot	1.244
Brabant ell in Germany . . .	2.268
Brescia foot	1.560
Brescian braccio	2.092
Brussels foot	.902
—— greater ell	2.278
—— lesser ell	2.245
China mathematical foot . . .	1.127
—— Imperial foot	1.051
Chinese li	606.
Constantinople foot	2.195
Copenhagen foot	1.049
Dresden foot	.929
—— ell = 2 feet	1.857
Florence foot	.995
—— braccio	1.900
Genoa palm	.812
—— canna	7.300
Geneva foot	1.919
Hamburgh foot	.933
Lisbon foot	.952
Madrid foot	.915
—— vara	3.263
Malta palm	.915
Moscow foot	.928
Naples palm	.861
—— canna	6.908
Paris foot	1.066
Paris metre	3.281
Rome palm	.733
—— foot	.966
—— deto . . . ($\frac{1}{16}$ foot) . .	.0604
—— oncio . . ($\frac{1}{12}$ foot) . .	.0805
—— palmo	.2515
—— palmo di architettura .	.7325
—— canna di architettura .	7.325

Rome staiolo	4.212
——— canna dei mericanti (8 palms)	6.5365
——— braccio dei mercanti (4palms)	2.7876
——— braccio di tessitor di tela	2.0868
——— braccio di architettura .	2.561
Russian archine	2.3625
——— arschin	2.3333
——— verschock, $\frac{1}{16}$ arschin	.1458
Stockholm foot	1.073
Turin foot	1.676
——— ras	1.958
——— trabuco	10.085
Tyrol foot	1.096
——— ell	2.639
Venice foot	1.137
——— braccio of silk	2.108
——— ell	2.089
——— braccio of cloth	2.250
Vienna foot	1.036
——— ell	2.557
——— post mile	24888.
Warsaw foot	1.169

The yoke of land, a description of measure in Austria, contains 1600 square fathoms: "1 metz, or bushel, 1.9471 cubic feet. 1 eimer = 40 kannen = 1.792 cubic feet of Vienna; 1 fass = 10 eimer."

In Sweden, a kanne contains 106 cubic Swedish inches.

Measure, in geometry, denotes any quantity assumed as one, or unity, to which the ratio of other homogeneous or similar quantities is expressed. This definition is somewhat more agreeable to practice than that of Euclid, who defines measure, a quantity which, being repeated any number of times, becomes equal to another. This latter definition answers only to the idea of an arithmetical measure, or quota-part.

Measure *of an angle,* is an arch described from the vertex in any place between its legs. Hence angles are distinguished by the ratio of the arches, described from the vertex between the legs to the peripheries. Angles then are distinguished by those arches; and the arches are distinguished by their ratio to the periphery: thus an angle is said to be of so many degrees as there are in the said arch. See Angle.

Measure *of a figure,* or plane surface, is a square whose side is one inch, foot, yard, or some other determinate length. Among geometricians, it is usually a rod called a square rod, divided into ten square feet, and the square feet into ten square digits: hence square measures.

Measure *of a line,* any right line taken at pleasure, and considered as unity. The modern geometricians use a decempeda, or perch, divided into ten equal parts, called feet; the feet they subdivide into ten digits, and the digit into ten lines, &c.

Measure *of the mass, or quantity of matter,* in mechanics, is its weight; it being apparent that all the matter which coheres and move with a body, gravitates with it, and it being found by experiment that the gravities of homogeneal bodies are in proportion to their bulks, hence, while the mass continues the same, the weight will be the same, whatever figure it put on; by which is meant its absolute weight, for as to its specific, that varies as the quantity of the surface varies.

Measure *of a number,* in arithmetic, such a number as divides another without leaving any fraction: thus 9 is a measure of 27.

Measure *of a solid,* is a cube whose side is one inch, foot, yard, or any other determinate length. In geometry, it is a cubic perch, divided into cubic feet, digits, &c.: hence cubic measures, or measures of capacity.

Measure *of velocity,* in mechanics, the space passed over by a moving body in a given time. To measure a velocity, therefore, the space must be divided into as many equal parts as the time is conceived to be divided into; the quantity of space answering to such an article of time is the measure of the velocity.

Measure *for horses,* is the hand, which, by statute, contains four inches.

Measure is also used to signify the cadence and time observed in poetry, dancing, and music, to render them regular and agreeable. See Metre.

Measure, in music, the interval or space of time which the person who beats time takes between the rising and falling of his hand, in order to conduct the movement sometimes quicker and sometimes slower, according to the music or subject that is to be sung or played. See Time.

MECHANICAL, in mathematics, denotes a construction of some problem, by the assistance of instruments, as the duplicature of the cube and quadrature of the circle, in contradistinction to that which is done in an accurate and geometrical manner.

Mechanical *curve,* is a curve, according to Des Cartes, which cannot be defin-

ed by any algebraic equation; and so stands contra-distinguished from algebraic or geometrical curves.

Leibnitz and others call these mechanical curves transcendental, and dissent from Des Cartes in excluding them out of geometry. Leibnitz found a new kind of transcendental equations, whereby these curves are defined; but they do not continue constantly the same in all points of the curve, as algebraic ones do.

MECHANICS, is the science which treats of the laws of the equilibrium and motion of solid bodies; of the forces by which bodies, whether animate or inanimate, may be made to act upon one another; and of the means by which these may be increased, so as to overcome such as are most powerful. As this science is closely connected with the arts of life, and particularly with those which existed even in the rudest ages of society, the construction of machines must have been practised long before the theory upon which their principles depend could have been understood. Hence we find in use among the ancients, the lever, the pulley, the crane, the capstan, and many other simple machines, at a period when mechanics, as a science, were unknown. In the remains of Egyptian architecture are beheld the most surprising marks of mechanical genius. The elevation of immense and ponderous masses of stone to the tops of their stupendous fabrics, must have required an accumulation of mechanical power, which is not in the possession of modern architects. We are indebted to Archimedes for the foundation of this science: he demonstrated, that when a balance with unequal arms is in equilibrio, by means of two weights in its opposite scales, these weights must be reciprocally proportional to the arms of the balance. From this general principle the mathematician might have deduced all the other properties of the lever, but he did not follow the discovery through all its consequences. In demonstrating the leading property of the lever, he lays it down as an axiom, that if the two arms of the balance are equal, the weights must be equal, to give an equilibrium. Reflecting on the construction of the balance, which moved upon a fulcrum, he perceived that the two weights exerted the same pressure on the fulcrum as if they had both rested on it. He then advanced another step, and considered the sum of these two weights as combined with a third, and then the sum of the three with a fourth, and so on, and perceived that in every such combination the fulcrum must support their united weight; and, therefore, that there is in every combination of bodies, and in every single body which may be considered as made up of a number of lesser bodies, a centre of pressure or gravity. This discovery Archimedes applied to particular cases, and pointed out the method of finding the centre of gravity of plane surfaces, whether bounded by a parallelogram, a triangle, a trapesium, or a parabola. See Centre *of gravity*.

Galileo, towards the close of the sixteenth century, made many important discoveries on this subject. In a small treatise on statics, he proved that it required an equal power to raise two different bodies to altitudes, in the inverse ratio of their weights, or that the same power is requisite to raise ten pounds to the height of one hundred feet, and twenty pounds fifty feet. It is impossible for us to follow this great man in all his discoveries. In his works, which were published early in the seventeenth century, he discussess the doctrine of equable motions in various theorems, containing the different relations between the velocity of the moving body, the space which it describes, and the time employed in its description. He treats also of accelerated motion, considers all bodies as heavy, and composed of heavy parts, and infers that the total weight of the body is proportional to the number of the particles of which it is composed. On this subject he reasons in the following manner: "As the weight of a body is a power always the same in quantity, and as it constantly acts without interruption, the body must be continually receiving from it equal impulses in equal and successive instants of time. When the body is prevented from falling, by being placed on a table, its weight is incessantly impelling it downwards; but these impulses are destroyed by the resistance of the table, which prevents it from yielding to them. But where the body falls freely, the impulses which it perpetually receives are perpetually accumulating, and remain in the body unchanged in every respect, except the diminution which they experience from the resistance of the air: hence it follows, that a body falling freely is uniformly accelerated, or receives equal increments of velocity in equal times. He then demonstrated that the time in which any space is described by a motion uniformly accelerated from rest,

is equal to the time in which the same space would be described by an uniform equable motion, with half the final velocity of the accelerated motion, and that in every motion uniformly accelerated from rest, the spaces described are in the duplicate ratio of the times of description: after this he applied the doctrine to the ascent and descent of bodies on inclined planes. For a more particular account we may refer to Dr. Keil's "Physics."—Under the articles CENTRE *of gravity*, DYNAMICS, ELASTICITY, FORCE, GRAVITATION, MOTION, &c. will be found much relating to the doctrine of mechanics; we shall therefore in this place chiefly treat of the mechanical powers, which are usually reckoned six in number: *viz.* the lever; the wheel and axis, or, as it is frequently called, "the axis in peritrochio;" the pulley; the inclined plane; the wedge; and the screw. Some writers on this subject reduce the six to two, *viz.* the lever, and the inclined plane; the pulley, and wheel and axis being, in their estimation, assemblages of the lever; and the wedge and the screw being modifications of the inclined plane.

When two forces act against each other, by the intervention of a machine, the one is denominated the power, and the other the weight. The weight is the resistance to be overcome, or the effect to be produced. The power is the force, whether animate or inanimate, which is employd to overcome that resistance, or to produce the required effect.

The power and weight are said to balance each other, or to be in equilibrio, when the effort of the one to produce motion in one direction, is equal to the effort of the other to produce it in the opposite direction; or when the weight opposes that degree of resistance which is precisely required to destroy the action of the power. The power of a machine is calculated when it is in a state of equilibrium. Having discovered what quantity of power will be requisite for this purpose, it will then be necessary to add so much more, *viz.* one-fourth, or, perhaps, one-third, to overcome the friction of the machine, and give it motion.

The lever is the simplest of all machines, and is a straight bar of iron, wood, or other material, supported on, and moveable about a prop called the fulcrum. In the lever, there are three circumstances to be principally attended to: 1. The fulcrum, or prop, by which it is supported, or on which it turns as a centre of motion: 2. The power to raise and support the weight: 3. The resistance or weight to be raised or sustained. The points of suspension are those points where the weights really are, or from which they hang freely. The power and the weight are always supposed to act at right angles to the lever, except it be otherwise expressed. The lever is distinguished into three sorts, according to the different situations of the fulcrum, or prop, and the power, with respect to each other. 1. When the prop is placed between the power and the weight, as in steel-yards, scissars, pincers, &c. 2. When the prop is at one end of the lever, the power at the other, and the weight between them, as in cutting knives, fastened at, or near the point of the blade; also in oars moving a boat, the water being the fulcrum. 3. When the prop is at one end, the weight at the other, and the power applied between them, as in tongs, sheers, &c.

The lever of the first kind is principally used for loosening large stones; or to raise great weights to small heights, in order to get ropes under them, or other means of raising them to still greater heights: it is the most common species of lever. A B C (Plate I. Mechanics, fig. 1.) is a lever of this kind, in which F is the fulcrum, A the end at which the power is applied, and C the end where the weight acts. To find when an equilibrium will take place between the power and the weight, in this as well as in every other species of lever, we must observe, that when the momenta, or quantities of force, in two bodies are equal, they will balance each other. Now, let us consider when this will take place in the lever. Suppose the lever AB, fig. 2, to be turned on its axis, or fulcrum, so as to come into the situation DC; as the end D is farthest from the centre of motion, and as it has moved through the arch AD in the same time as the end B moved through the arch BC, it is evident that the velocity of AB must have been greater than that of B. But the momenta being the products of the quantities of matter multiplied into the velocities, the greater the velocity, the less the quantity of matter to obtain the same product. Therefore, as the velocity of A is the greatest, it will require less matter to produce an equilibrium than B.

Let us now examine how much more weight B will require than A, to balance. As the radii of circles are in proportion to their circumferences, they are also proportionate to similar parts of them; therefore, as the arches, AD, CB, are similar, the radius, or arm, DE, bears the same proportion to EC that the arch AD bears

to CB. But the arches AD and CB represent the velocities of the ends of the lever, because they are the spaces which they moved over in the same time; therefore the arms DE and EC may also represent these velocities. Hence, an equilibrium will take place, when the length of the arm AE, multiplied into the power A, shall equal EB, multiplied into the weight B; and, consequently, that the shorter EB is, the greater must be the weight B; that is, the power and the weight must be to each other inversely, as their distances from the fulcrum. Thus, suppose AE, the distance of the power from the prop, to be twenty inches, and EB, the distance of the weight from the prop, to be eight inches, also the weight to be raised at B to be five pounds; then the power to be applied at A, must be two pounds; because the distance of the weight from the fulcrum eight, multiplied into the weight five, makes forty; therefore twenty, the distance of the power from the prop, must be multiplied by two, to get an equal product; which will produce an equilibrium.

The second kind of lever, when the weight is between the fulcrum and the power, is represented by fig. 3, in which A is the fulcrum, B the weight, and C the power. The advantage gained by this lever, as in the first, is as great as the distance of the power from the prop exceeds the distance of the weight from it. Thus, if the point *a*, on which the power acts, be seven times as far from A as the point *b*, on which the weight acts, then one pound applied at C will raise seven pounds at B. This lever shews the reason why two men carrying a burden upon a stick between them, bear shares of the burden, which are to one another in the inverse proportion of their distances from it.

It is likewise applicable to the case of two horses of unequal strength to be so yoked, as that each horse may draw a part proportionable to his strength; which is done by so dividing the beam they pull, that the point of traction may be as much nearer to the stronger horse than to the weaker, as the strength of the former exceeds that of the latter. To this kind of lever may be reduced rudders of ships, doors turning upon hinges, &c. The hinges being the centre of motion, the hand applied to the lock is the power, while the door is the weight to be moved.

If in this lever we suppose the power and weight to change places, so that the power may be between the weight and the prop, it will become a lever of the third kind; in which, that there may be a balance between the power and the weight, the intensity of the power must exceed the intensity of the weight just as much as the distance of the weight from the prop exceeds the distance of the power. Thus, let E, fig 4, be the prop of the lever EF, and W a weight of one pound, placed three times as far from the prop as the power P acts at F, by the cord going over the fixed pulley D; in this case, the power must be equal to three pounds, in order to support the weight of one pound. To this sort of lever are generally referred the bones of a man's arm; for when he lifts a weight by the hand, the muscle that exerts its force to raise that weight, is fixed to the bone about one tenth part as far below the elbow as the hand is. And the elbow being the centre round which the lower part of the arm turns, the muscle must therefore exert a force ten times as great as the weight that is raised. As this kind of lever is a disadvantage to the moving power, it is used as little as possible; but in some cases it cannot be avoided; such as that of a ladder, which being fixed at one end, is by the strength of a man's arms reared against a wall.

What is called the hammer-lever, differs in nothing but its form from a lever of the first kind. Its name is derived from its use, that of drawing a nail out of wood by a hammer. Suppose the shaft of a hammer to be five times as long as the iron part which draws the nail, the lower part resting on the board as a fulcrum; then, by pulling backwards the end of the shaft, a man will draw a nail with one-fifth part of the power that he must use to pull it out with a pair of pincers; in which case, the nail would move as fast as his hand; but with the hammer, the hand moves five times as much as the nail by the time that the nail is drawn out. Hence it is evident, that in every species of lever there will be an equilibrium, when the power is to the weight as the distance of the weight from the fulcrum is to the distance of the power from the fulcrum. In experiments with the lever we take care that the parts are perfectly balanced before the weights and powers are applied. The bar, therefore, has the short end so much thicker than the long arm, as will be sufficient to balance it on the prop.

If several levers be combined together in such a manner, as that a weight being appended to the first lever may be supported by a power applied to the last, as in fig. 5, which consists of three levers

of the first kind, and is so contrived, that a power applied at the point L of the lever C, may sustain a weight at the point S of the lever A, the power must here be to the weight, in a ratio, or proportion, compounded of the several ratios, which those powers that can sustain the weight by the help of each lever, when used singly and apart from the rest, have to the weight. For instance, if the power which can sustain the weight W by the help of the lever A, be to the weight as 1 to 5; and if the power which can sustain the same weight, by the lever B alone, be to the weight as 1 to 4; and if the power which could sustain the same weight by the lever C, be to the weight as 1 to 5; then the power which will sustain the weight by help of the three levers joined together, will be to the weight in a proportion consisting of the several proportions multiplied together, of 1 to 5, 1 to 4, and 1 to 5; that is as 1 : $5 \times 4 \times 5$, or of 1 : 100. For since, in the lever A, a power equal to one-fifth of the weight W, pressing down the lever at L, is sufficient to balance the weight, and since it is the same thing whether that power be applied to the lever A at L, or the lever B at S, the point S bearing on the point L, a power equal to one-fifth of the weight P, being applied to the point S of the lever B, will support the weight; but one-fourth of the same power being applied to the point L of the lever B, and pushing the same upward, will as effectually depress the point S of the same lever, as if the whole power were applied at S; consequently a power equal to one-fourth of one-fifth, that is one-twentieth of the weight P, being applied to the point L of the lever B, and pushing up the same, will support the weight: in like manner, it matters not whether that force be applied to the point L of the lever B, or to the point S of the lever C, since, if S be raised, L, which rests on it, must be raised also; but one-fifth of the power applied at the point L of the lever C, and pressing it downwards, will as effectually raise the point S of the same lever, as if the whole power were applied at S, and pushed up the same; consequently a power equal to one-fifth of one-twentieth, that is, one hundredth part of the weight P, being applied to the point L of the lever C, will balance the weight at the point S of the lever A. This method of combining levers is frequently used in machines and instruments, and is of great service, either in obtaining a greater power, or in applying it with more convenience.

The balance, an instrument of very extensive use in comparing the weights of bodies, is a lever of the first kind, whose arms are of equal length. The points from which the weights are suspended being equally distant from the centre of motion, will move with equal velocity; consequently if equal weights be applied, their momenta will be equal, and the balance will remain in equilibrio. In order to have a balance as perfect as possible, it is necessary to attend to the following circumstances: 1. The arms of the beam ought to be exactly equal, both as to weight and length. 2. The points from which the scales are suspended, should be in a right line, passing through the centre of gravity of the beam; for by this, the weights will act directly against each other, and no part of either will be lost, on account of any oblique direction. 3. If the fulcrum be placed in the centre of gravity of the beam, and if the fulcrum and the points of suspension be in the same right line, the balance will have no tendency to one position more than another, but will rest in any position it may be placed in, whether the scales be on or off, empty or loaded. If the centre of gravity of the beam, when level, be immediately above the fulcrum, it will overset by the smallest action; that is, the end which is lowest will descend; and it will do this with more swiftness, the higher the centre of gravity be, and the less the points of suspension be loaded. But if the centre of gravity of the beam be immediately below the fulcrum, the beam will not rest in any position but when level; and if disturbed from that position and then left at liberty, it will vibrate, and at last come to rest on the level. In a balance, therefore, the fulcrum ought always to be placed a little above the centre of gravity. Its vibrations will be quicker, and its horizontal tendency stronger, the lower the centre of gravity, and the less the weight upon the points of suspension. 4. The friction of the beam upon the axis ought to be as little as possible; because, should the friction be great, it will require a considerable force to overcome it; upon which account, though one weight should a little exceed the other, it will not preponderate, the excess not being sufficient to overcome the friction, and bear down the beam. 5. The pivots, which form the axis or fulcrum, should be in a straight line, and at right angles to the beam. 6.

The arms should be as long as possible, relatively to their thickness, and the purposes for which they are intended, as the longer they are the more sensible is the balance. They should also be made as stiff and inflexible as possible; for if the beam be too weak, it will bend, and become untrue. 7. The rings, or the piece on which the axis bears, should be hard and well polished, parallel to each other, and of an oval form, that the axis may always keep its proper bearing, or remain always at the lowest point. 8. If the arms of a balance be unequal, the weights in equipoise will be unequal in the same proportion. The equality of the arms is of use, in scientific pursuits, chiefly in the making of weights by bisection. A balance with unequal arms will weigh as accurately as another of the same workmanship with equal arms, provided the standard weight itself be first counterpoised, then taken out of the scale, and the thing to be weighed be put into the scale, and adjusted against the counterpoise. Or, when proportional quantities only are considered, the bodies under examination may be weighed against the weights, taking care always to put the weights in the same scale; for then, though the bodies may not be really equal to the weights, yet their proportions amongst each other will be the same as if they had been accurately so. 9. Very delicate balances are not only useful in nice experiments, but are likewise much more expeditious than others in common weighing. If a pair of scales, with a certain load, be barely sensible to one-tenth of a grain, it will require a considerable time to ascertain the weight to that degree of accuracy, because the turn must be observed several times over, and is very small. But if no greater accuracy were required, and scales were used, which would turn with one-hundredth of a grain, a tenth of a grain more or less would make so great a difference in the turn, that it would be seen immediately.

The statera, or Roman steel-yard, is a lever of the first kind, and is used for finding the weights of different bodies, by one single weight placed at different distances from the prop or centre of motion D, fig. 6. For, the shorter arm D G is of such a weight as exactly to counterpoise the longer arm D X. If this arm be divided into as many equal parts as it will contain, each equal to G D, the single weight P (which we may suppose to be one pound) will serve for weighing any thing as heavy as itself, or as many times heavier as there are divisions in the arm DX, or any quantity between its own weight and that quantity. As for example, if P be one pound, and placed at the first division 1 in the arm D X, it will balance one pound in the scale at W; if it be removed to the second division at 2, it will balance two pounds in the scale; if to the third, three pounds; and so on to the end of the arm D X. If any of these integral divisions be subdivided into as many equal parts as a pound contains ounces, and the weight P be placed at any of these subdivisions, so as to counterpoise what is in the scale, the pounds and odd ounces therein will by that means be ascertained. In the Danish and Swedish steel-yard, the body to be weighed, and the constant weight, are fixed at the extremities of the steel-yard, but the point of suspension or centre of motion moves along the lever till the equilibrium takes place The centre of motion therefore shews the weight of the body.

The wheel and axle, or axis in peritrochio, is a machine much used, and is made in a variety of forms. It consists of a wheel with an axle fixed to it, so as to turn round with it; the power being applied at the circumference of the wheel, the weight to be raised is fastened to a rope which coils round the axle.

A B (fig. 7.) is a wheel, and C D an axle fixed to it, and which moves round with it. If the rope which goes round the wheel be pulled, and the wheel turned once round, it is evident that as much rope will be drawn off as the circumference of the wheel; but while the wheel turns once round, the axle turns once round; and consequently the rope by which the weight is suspended will wind once round the axis, and the weight will be raised through a space equal to the circumference of the axis. The velocity of the power, therefore, will be to that of the weight, as the circumference of the wheel to that of the axis. In order, therefore, that the power and the weight may be in equilibrio, the power must be to the weight as the circumference of the wheel to that of the axis. Circles being to each other as their respective diameters, the power is to the weight, as the diameter also of the axis to that of the wheel Thus, suppose the diameter of the wheel to be eight inches, and the diameter of the axis to be one inch; then one ounce acting as the power P, will balance eight ounces as a weight W; and a small additional force will cause the wheel to turn with its axis, and raise the weight; and

for every inch which the weight rises the power will increase eight inches.

The wheel and axis may be considered as a kind of perpetual lever, (fig. 8.) of which the fulcrum is the centre of the axis, and the long and short arms the diameter of the wheel and the diameter of the axis. From this it is evident, that the longer the wheel, and the smaller the axis, the stronger is the power of this machine; but then the weight must rise slower in proportion. A capstan is a cylinder of wood, with holes in it, into which are put bars, or levers, to turn it round; these are like the spokes of a wheel without the rim. Sometimes the axis is turned by a winch fastened to it, which, in this respect, serves for a wheel, and is more powerful, in proportion to the largeness of the circle it describes, compared with the diameter of the axle. When the parts of the axis differ in thickness, and weights are suspended at the different parts, they may be sustained by one and the same power applied to the circumference of the wheel, provided the product arising from the multiplication of the power into the diameter of the wheel, be equal to the sum of the products arising from the multiplication of the several weights into the diameters of those parts of the axis from which they are suspended. In considering the theory of the wheel and axle, we have supposed the rope that goes round the axis to have no sensible thickness; but as in practice this cannot be the case, if it is a thick rope, or if there be several folds of it round the axis, you must measure to the middle of the outside rope to obtain the diameter of the axis, for the distance of the weight from the centre is increased by the coiling up of the rope.

If teeth are cut in the circumference of a wheel, and if they work in the teeth of another wheel of the same size as fig. 9. it is evident that both the wheels will revolve in the same time; and the weight appended to the axle of the wheel B, will be raised in the same time as if the axle had been fixed to the wheel A. But if the teeth of the second wheel be made to work in teeth made in the axle of the first, as at fig. 10. as every part of the circumference of the second wheel is applied successively to the circumference of the axle of the first, and as the former is much greater than the latter, it is evident, that the first wheel must go round as many times more than the second, as the circumference of the second wheel exceeds that of the first axle. In order to a balance here, the power must be to the weight, as the product of the circumferences, or diameters of the two axles multiplied together, is to the circumferences or diameters of the two wheels. This will become sufficiently clear, if it be considered as a compound lever, which was explained above. Instead of a combination of two wheels, three or four wheels may work in each other, or any number; and by thus increasing the number of wheels, or by proportioning the wheels to the axis, any degree of power may be acquired. To this sort of engine belong all cranes for raising great weights; and in this case the wheel may have cogs all round it, instead of handles; and a small lanthorn, or trundle, may be made to work in the cogs, and be turned by a winch; which will make the power of the engine to exceed the power of the man who works it, as much as the number of revolutions of the winch exceeds those of the axle, when multiplied by the excess of the length of the winch above the length of the semi-diameter of the axle, added to the semi-diameter or half thickness of the rope, by which the weight is drawn up. See Crane.

The construction of the main-spring-box of the fusee of a watch, round which the chain is coiled, will illustrate the principle of the wheel and axis. The box may be considered as the wheel, and the fusee the axle or pinion, to which the chain communicates the motion of the box. The power resides in the spring wound round an axis in the centre of the box, and the weight is applied to the lower circumference of the fusee. As the force of the spring is greatest when newly wound up, and gradually decreases as it unwinds itself, it is necessary that the fusee should have different radii, so that the chain may act upon the smallest part of the fusee when its force is greatest, and upon the largest part of the fusee when its force is least; for the equable motion of the watch requires, that the inequality in the action of the spring should be counteracted so as to produce an uniform effect.

The pulley is a small wheel turning on an axis, with a drawing rope passing over it; the small wheel is usually called a sheeve, and is so fixed in a box, or block, as to be moveable round a pin passing through its centre. Pullies are of two kinds; fixed, which do not move out of their places; and moveable, which rise and fall with the weight.

When a pulley is fixed, as Plate II. Mechanics, fig. 11. two equal weights

suspended to the ends of a rope passing over it will balance each other, for they stretch the rope equally, and if either of them be pulled down through any given space, the other will rise through an equal space in the same time; and consequently, as the velocities of both are equal, they must balance each other. This kind of pulley, therefore, gives no mechanical advantage; but its use consists in changing the direction of the power, and sometimes enabling it to be applied with more convenience. By it, a man may raise a weight to any point, as the top of a building, without moving from the place he is in; whereas, otherwise, he would have been obliged to ascend with the weight; it also enables several men together to apply their strength to the weight by means of the rope. The moveable pulley represented at A (fig. 12.) is fixed to the weight W, and rises and falls with it. In comparing this to a lever, the fulcrum must be considered as at A, the weight acts upon the centre *c*, and the power is applied at the extremity of the lever D. The power, therefore, being twice as far from the fulcrum as the weight is, the proportion between the power and weight, in order to balance each other, must be as 1 to 2. Whence it appears, that the use of this pulley doubles the power, and that a man may raise twice as much by it as by his strength alone. Again, every moveable pulley hangs by two ropes equally stretched, and which must, consequently, bear equal parts of the weight; but the rope A B being made fast at B, half the weight is sustained by it, and the other part of the rope, to which the power is applied, has but half the weight to support; consequently, the advantage gained by this pulley is as 2 to 1. When the upper and fixed block contains two pullies, which only turn upon their axis, and the lower moveable block contains also two, which not only turn on their axis, but rise with the weight F (fig. 13.) the advantage gained is as 4 to 1. For each lower pulley will be acted upon by an equal part of the weight; and because in each pulley that moves with the weight a double increase of power is gained, the force by which F may be sustained will be equal to half the weight divided by the number of lower pullies; that is, as twice the number of lower pullies is to 1, so is the weight suspended to the power. But if the extremity C (fig. 14.) be fixed to the lower block, it will sustain half as much as a pulley; consequently, here the rule will be, as twice the number of pullies adding unity is to 1, so is the weight to the power. These rules hold good, whatever may be the number of pullies in the blocks. If, instead of one rope going round all the pullies, the rope belonging to each pulley be made fast at top, as in fig. 15, a different proportion between the power and the weight will take place. Here it is evident, that each pulley doubles the power; thus, if there are two pullies, the power will sustain four times the weight; if three pullies, eight times the weight; if four pullies, sixteen times; and so on: that is, the power P, of 1*lb.* will sustain a weight W of 16*lb.*

When pullies in blocks are placed perpendicularly under each other, on separate pins, they occupy considerable space, and would not in general answer; it is, therefore, common to place all the pullies in each block on the same pin, by the side of each other, as in fig. 16. but the advantage and rule for the power are the same here as in fig. 13 and 14. A pair of blocks with the rope fastened round it, is commonly called a tackle.

To avoid, in a great measure, the friction of several pullies running on different pivots, Mr. James White, a very able mechanic, invented the concentric pulley, (fig. 17.) for which he obtained a patent. O and R are two brass pullies in which grooves are cut; round these a cord is passed, by which means the two answer the same purpose of so many distinct pullies as there are grooves; and the advantage gained is found by doubling the number of grooves in the lower block. In this case the advantage gained is 12, that is, a power of 12*lb.* will balance a weight of 144. The concentric pulley removes very considerably the shaking motion of the common pulley, as well as the friction.

The inclined plane is of very great use in rolling up heavy bodies, such as casks, wheel-barrows, &c. It is formed by placing boards, or earth, in a sloping direction. The force with which a body descends upon an inclined plane is to the force of its absolute gravity, by which it would descend perpendicularly in free space, as the height of the plane is to its length. For suppose the plane A B (fig. 18.) to be parallel to the horizon, the cylinder C will keep at rest on any part of the plane where it is laid. If the plane be placed perpendicularly, as A B, (fig. 19.) the cylinder C will descend with its whole force of gravity, because the plane contributes nothing to its support or hindrance; and therefore it would require a power equal to its whole weight to keep

it from descending. Let A B (fig. 10.) be a plane parallel to the horizon, and A D a plane inclined to it; and suppose the whole length A D to be four times as great as the perpendicular D B. In this case the cylinder E will be supported upon the plane D A, and kept from rolling, by a power equal to a fourth part of the weight of the cylinder; therefore a weight may be rolled up this inclined plane, by a third part of the power which would be sufficient to draw it up by the side of an upright wall. It must also be evident, that the less the angle of elevation, or the gentler the ascent is, the greater will be the weight which a given power can draw up; for the steeper the inclined plane is, the less does it support of the weight; and the greater the tendency which the weight has to roll; consequently, the more difficult for the power to support it: the advantage gained by this mechanical power, therefore, is as great as its length exceeds its perpendicular height. To the inclined plane may be reduced all hatchets, chisels, and other edge-tools.

The inclined plane, when combined with other machinery, is often of great use in the elevation of weights: it has been likewise made use of in the late Duke of Bridgewater's canal. After this canal has extended about 40 miles on the same level, it is joined to a subterraneous navigation about 12 miles long, by means of an inclined plane, and this subterraneous portion is again connected by an inclined plane with another portion 100 feet above it. This plane is a stratum of stone which slopes one foot in four, and is about 450 feet long. The boats are conveyed from one level to another by means of a windlass, so that a loaded boat descending along the plane turns the axis of the windlass, and raises an empty boat.

The fifth mechanical power or machine is the wedge; which may be considered as two equally inclined planes, joined together at their bases; then D G (fig. 21.) is the whole thickness of the wedge at its back ABGD, where the power is applied; EF is the depth or height of the wedge; BF the length of one of its sides; and OF is its sharp edge, which is entered into the wood intended to be split, by the force of a hammer or mallet striking perpendicularly on its back. Thus, AB (fig. 22.) is a wedge driven into the cleft CED of the wood FG. When the wood does not cleave at any distance before the wedge, there will be an equilibrium between the power impelling the wedge downward and the resistance of the wood acting against the two sides of the wedge, when the power is to the resistance as half the thickness of the wedge at its back is to the length of either of its sides; because the resistance then acts perpendicularly to the sides of the wedge. But when the resistance on each side acts parallel to the back, the power that balances the resistances on both sides will be, as the length of the whole back of the wedge is to double its perpendicular height.

When the wood cleaves at any distance before the wedge (as it generally does) the power impelling the wedge will not be to the resistance of the wood as the length on the back of the wedge is to the length of both its sides, but as half the length of the back is to the length of either side of the cleft, estimated from the top or acting part of the wedge. For, if we suppose the wedge to be lengthened down from the top CE, to the bottom of the cleft at D, the same proportion will hold; namely, that the power will be to the resistance as half the length of the back of the wedge is to the length of either of its sides: or, which amounts to the same thing, as the whole length of the back is to the length of both the sides. The wedge is a very great mechanical power, since not only wood, but even rocks, can be split by it; which it would be impossible to effect by the lever, wheel, and axle, or pulley; for the force of the blow, or stroke, shakes the cohering parts, and thereby makes them separate more easily.

The sixth and last mechanical power is the screw; which cannot properly be called a simple machine, because it is never used without the application of a lever or winch to assist in turning it; and then it becomes a compound engine of a very great force, either in pressing the parts of bodies closer together, or in raising great weights. It may be conceived to be made by cutting a piece of paper, ABC (fig. 23.) into the form of an inclined plane or half wedge; and then wrapping it round a cylinder (fig. 24.) the edge of the paper AC will form a spiral line round the cylinder, which will give the thread of the screw. It being evident that the winch must turn the cylinder once round, before the weight of resistance can be moved from one spiral winding to another, as from *d* to *c*; therefore, as much as the circumference of a circle described by the handle of the winch is greater than the interval or distance between the spirals, so much is the force of the screw. Thus, supposing the distance of the spirals to be half an inch, and the

length of the winch twelve inches, the circle described by the handle of the winch where the power acts, will be 76 inches nearly, or about 152 half inches; and consequently 152 times as great as the distance between the spirals; and therefore a power at the handle, whose intensity is equal to no more than a single pound, will balance 152 pounds acting against the screw; and as much additional force as is sufficient to overcome the friction, will raise the 152 pounds; and the velocity of the power will be to the velocity of the weight as 152 to 1. Hence it appears, that the longer the winch is, and the nearer the spirals are to one another, so much the greater is the force of the screw.

A machine for shewing the force or power of the screw may be contrived in the following manner: let the wheel C have a screw (fig. 25.) on its axis, working in the teeth of the wheel D, which suppose to be 48 in number. It is plain, that for every time the wheel C and screw are turned round by the winch A, the wheel D will be moved one tooth by the screw; and therefore, in 48 revolutions of the winch, the wheel D will be turned once round. Then, if the circumference of a circle, described by the handle of the winch A, be equal to the circumference of a groove round the wheel D, the velocity of the handle will be 48 times as great as the velocity of any given point in the groove. Consequently, if a line G goes round the groove, and has a weight of 48 pounds hung to it, a power equal to 1 pound at the handle will balance and support the weight. To prove this by experiment, let the circumferences of the grooves of the wheels C and D be equal to one another; and then if a weight H, of one pound, be suspended by a line going round the groove of the wheel C, it will balance a weight of 48 pounds hanging by the line G; and a small addition to the weight H will cause it to descend, and so raise up the other weight.

If a line G, instead of going round the groove of the wheel D, goes round its axle I, the power of the machine will be as much increased as the circumference of the groove exceeds the circumference of the axle: which supposing it to be six times, then one pound at H will balance six times 48, or 288 pounds, hung to the line on the axle: and hence the power or advantage of this machine will be as 288 to 1. That is to say, a man, who by his natural strength could lift an hundred weight, will be able to raise 288 cwts. by this engine. If a system of pullies were applied to the cord H, the power would be increased to an amazing degree. When a screw acts in a wheel in this manner, it is called an endless screw. When it is not employed in turning a wheel, it consists of two parts: the first is called the male, or outside screw, being cut in such a manner as to have a prominent part going round the cylinder in a spiral manner; which prominent part is called the thread of the screw; the other part, which is called the female, or inside screw, is a solid body, containing a hollow cylinder, whose concave surface is cut in the same manner as the convex surface of the male screw, so that the prominent parts of the one may fit the concave parts of the other. A very considerable degree of friction always acts against the power in a screw; but this is fully compensated by other advantages; for on this account the screw continues to sustain a weight, even after the power is removed, or ceases to act, and presses upon the body against which it is driven. Hence the screw will sustain very great weights, insomuch, that several screws, properly applied, would support a large building, whilst the foundation was mending, or renewed.

The screw is of extensive use in the printing press, and in the press for coining money, and in a great variety of other purposes. It has lately been employed in the flour-mills in America, for pushing the flour which comes from the millstones to the end of a long trough, from which it is conveyed to other parts of the machinery, in order to undergo the remaining processes. In this case, the spiral threads are very large in proportion to the cylinder on which they are fixed. As the lever used with the screw moves through a large space, when compared with the velocity of its other extremity, or of any body which it puts in motion; the screw is of very great use in subdividing any space into a great number of minute parts. Hence it is employed in the engines for dividing mathematical instruments, &c. See Oscillation, Pendulum, Suspension, &c.

MEDAL. This word has generally been supposed to be derived from Metallum, from which we have the English term metal; but it may admit of some doubt whether the derivation is correct, as the word appears to have too comprehensive a sense to particularize a piece of gold, silver, brass, or copper, impressed with figures to convey to posterity some great historical occurrence, or to perpetuate the memory of a person who had rendered the

state in which he lived an essential service.

We are indebted to the very ancient inhabitants of the world for this method of immortalizing their most important acts and most exalted characters; a method, the discovery or invention of which, would do honour to an age enlightened by arts and literature, then unknown. Had the same inclination to preserve those indelible mementos prevailed throughout the countries which prompted the making of them, we should have possessed a series of valuable information now for ever interrupted, to the constant regret of the historian, who is compelled to wander in a maze of conjecture, caused by allusions in the works of ancient writers, that were well known to the public at the time when they were made, but all clue to which is entirely lost. The satisfaction demonstrated by the learned of every nation on the accidental discovery of an unknown medal, sufficiently evinces their importance; if the relief is tolerably perfect, or the inscription nearly or quite legible, every individual becomes an enthusiast in research, and it has frequently happened that an important blank in chronology, history, or geography, has been unexpectedly and satisfactorily filled by this means. One very material circumstance contributes to render ancient medals valuable, which is their undoubted authenticity; in short, they are the historical acts of kings and states, the durable gazettes of antiquity; they inform the world, that at such a period a monarch ascended a throne, a victory was achieved, the foundations of a city were laid, or a temple erected, and they sometimes introduce to our notice persons, towns, and buildings, which have not been mentioned by any of the ancient writers extant.

Viewing medals in this light, it is a matter of some surprise that collections have not been formed in every age and country; that they have not, may be inferred from the extreme rarity of some particular descriptions; had collections been universal, surely a much greater number of medals must have reached us, making due allowance for decay, violence, melting, and losses during foreign and civil wars. Mr. Pinkerton inclines to think the world entertained but little regard for the medals made by the numerous small states using the Greek characters and language, supposing that their numbers rendered them of little value; this idea is extremely probable, if extended to the mass of mankind; but as there ever has been individuals of superior taste and acquirements scattered in every soil, we might have imagined the aggregate of those persons sufficiently great to preserve a larger number than is now to be found.

Many ingenious speculations might be formed as to the origin of medals; it is not, however, safe or pleasant to wander in the shades of antiquity without guides, or a ray of light; we must therefore be contented with the few facts which have been gleaned by writers on this subject. From those it appears, that we are principally indebted to the Romans for the preservation of the most valuable Greek medals; indeed, that ambitious people did themselves more honour by their successful study of the arts of Greece, than by the conquests they achieved in every part of the globe then known; with minds elevated beyond the paltry consideration of envy, they not only collected the medals of that country, but directed their artists to imitate the beauty of their reliefs, and the gracefulness of their outlines. The encouragement thus afforded by the various governments of Rome, created a spirit of emulation amongst the higher orders of the public, and collections were formed, to which every subsequent cabinet has been more or less indebted. Whether the medals possessed by the curious at that period were methodically arranged, so as to preserve the chronology of facts, cannot now be ascertained; but we are very certain that numbers of great value and importance must have been irrecoverably lost since the time alluded to, and that the series, in many cases, has been interrupted by the havock committed at each conquest of the mistress of the world. The philosopher and the historian will ever dwell with regret on that long mental night which enveloped those happy regions, where science and the arts had flourished, and whence their influence had diverged to surrounding nations; but they must exult in the recollection of the gradual return of day, which at length reached its meridian, and exhibited a grand picture of learning and the liberal arts. Upon their revival the study of medals became an object of primary importance, and Petrarch appears at the head of those who justly appreciated their value; sensible of the spirit of emulation they were calculated to inspire, he sent the Emperor Charles IV. several, made in honour of great and good men, with an invitation to imitate their conduct.

Alphonso, King of Arragon, acted upon the principle recommended by Petrarch,

and carried a collection he had ordered to be made constantly with him, in order that he might remember the qualities which caused their being struck. Examples like those were not without imitation in succeeding periods, but the most noble and magnificent consequence was the Cabinet of Cosmo de Medici, which was for a long time the admiration of Europe. Keysler, who saw this collection in 1730, asserts, that "with regard to the number of old coins, they reckon at present three hundred and twelve medallions, among which are forty-five of silver. The largest copper medallion is a Julia, the consort of Septimus Severus. The copper coins of the smaller size amount to about eight hundred, and those of the larger size to one thosand eight hundred The middle sort, by the French called *Moyen Bronze*, are two thousand two hundred, and this collection is the most valuable and curious, containing a great number of Greek coins. Among the silver pieces are eight hundred consular ones, and upwards of two thousand others. Here are six hundred pieces of gold, and sixteen medallions of the same metal. I was assured by Bianchi, that the largest gold medal weighs one hundred and sixteen Louis d'ors, and represents the Emperor John Palæologus VI., who assisted at the Council of Florence."

The number of medals in gold, silver, and copper, struck in honour of cities and countries, amounts to fifteen hundred. The gold and copper ones of this assortment are the most curious. The whole collection consists of fourteen thousand ancient, and eight thousand modern medals. Of the latter there are nine hundred of gold, and two thousand of silver, amongst which the largest is that of Cosmo III., and upwards of three thousand in copper.

This collection eclipsed every other, though there were many of very great extent in different parts of the continent; nor have the learned of England been deficient in their exertions to procure those useful evidences of past transactions. Camden, who first engraved medals for his valuable works, is supposed to have been one of the first collectors: to whom may be added, Sir Robert Cotton. Henry, Prince of Wales, son of James I. possessed thirty thousand coins and medals. Archbishop Laud gave five thousand five hundred coins to the Bodleian library. The Earl of Arundel, celebrated for his taste in selecting specimens of antiquity, had an excellent collection of medals; and Evelyn enumerates the Dukes of Hamilton and Buckingham, Sir Thomas Fanshaw, Sir William Paston, Sir Thomas Hammer, Messrs. Sheldon, Selden, and many others, as having in their possession cabinets of medals Charles I., a monarch who would have done more to improve the state of the arts in England than all his predecessors, had his reign been happy, collected a vast number, which were lost after his dethronement; and his historian, Lord Clarendon, endeavoured to rival his royal master in this interesting pursuit, which appears to have been in some degree a favourite one with Oliver Cromwell.

Charles II. entertained a similar partiality for medals, but his successors have entirely neglected them, and suffered their subjects to set them an example, which it is much to be wished they had followed. Amongst those were Sir Hans Sloane, the Earls of Pembroke and Winchelsea, and several others, mentioned by Haym, who wrote about 1720. Since the above period our general knowledge of medals has been considerably increased, and the skill with which the most recent collections were made, does infinite honour to the penetration and acumen of our medallists, who are frequently enabled to detect fictitious pieces, which have been made with sufficient art to impose upon foreigners. Several noblemen and gentlemen now possess rich cabinets, and the British Museum contains a superb collection, derived from numerous sources.

Medals have from necessity been uniformly struck on copper, variously mixed with other substances, silver, and gold; the most ancient of the latter metal are evidently in its native state, neither purified or combined with copper, though there are some which are supposed to be of gold and silver. Philip of Macedon caused the gold used for coining in his dominions to be made of the utmost purity, and in this particular he was imitated by Alexander the Great, and others nearly his contemporaries. The Romans, profiting by the experience of ages, and perceiving that the purity of the metal improved the beauty of the impression, determined to use it in as perfect a state as possible; the silver coins of that people were less pure, and became at length greatly debased.

The pure brass medals, and the red, or copper, called by the ancients Cyprian brass, were generally covered by platina. The best mixture was electrum, composed of one fifth of silver, and the remainder of gold: in some instances this was a na-

tural combination, in others artificial. Pinkerton says, the earliest Lydian coins, and those of particular states of Asia Minor, are of this description, as are those of the Kings of the Bosphorus Cimmerius, during the imperial ages of Rome. The Egyptian coins, made when that country was under the dominion of Rome, were at first of good silver, but degenerated afterwards; indeed lead, and even tin, have been used for the purposes of money.

The shapeless coins of very great antiquity were mere fragments of metal, the value of which was regulated entirely by weight, and this method extended to the comparatively worthless substance, brass. The silver coins of Greece, first known as bearing marks, are those with a tortoise on one side, and indented on the other; it is extremely doubtful when these coins were made, but they are supposed to have been from the celebrated mint of Ægina, where, according to some writers, the first coinage of money took place by command of Phidon, King of the Argives. Herodotus asserts, that the Lydians invented the art of impressing figures on their coins, whether correctly or not, cannot now be decided. Phidon is said to have lived about eight hundred and fifty years before the Christian æra, and the tortoise is known to be the badge of the Peloponnesus.

The drachma, or eighth part of an ounce, was the leading denomination of the Grecian money, and their coins were generally named from their weights, though sometimes the case was reversed; the silver drachma was equivalent on a medium to nine-pence sterling, and the Romans considered their denarius as of the same value with the drachma. The didrachm of silver was double the amount of the drachma; the tridrachm was three drachmas; and the tetradrachm, the largest of Greek silver coins, except the tetradrachm of the Eginean standard, is equivalent to five shillings of our money.

The silver drachma was divided into several denominations, as the tetrobolion, worth a modern sixpence; the hemidrachm, or triobolion, the diobolion, the obulus, the hemiobolion, the tetartobolion, and the dichalcos; the latter was worth about a farthing and a half. Very few of those minute silver coins have reached us, and others are mentioned by Greek writers, which were still less, and are consequently entirely decayed, or have been overlooked or neglected for the larger species.

It may be proper in noticing these coins, to mention the figures impressed on some of them, for instance, Pallas and Proserpine on the tetradrachm, and the troizene; the cistophori had the mystic chest of Bacchus, with a serpent rising out of it; but the Athenian coins were the most numerous, though the execution of them was indifferent. The first copper coins extant are Syracusan; those of Greece are the chalcos, originally of very inconsiderable value. It does not appear that gold was used for this purpose in Greece before the reign of Philip of Macedon, and Athens was destitute of this description of money at the commencement of the Peloponnesian war; Sicily had set the example in this respect, the government of which island had issued gold coins four hundred and ninety-one years before Christ. The Χρυσος, or Philippus, was a didrachm, the common form of gold coins of very remote times, and was equal in value to one pound sterling. The Philippus was divided into four parts, and there were still smaller coins of this precious metal. The Διχρυσος, of Alexander and Lysimachus, was of greater value than the Philippus, and is said to have been worth forty shillings of our money. Some of the Egyptian monarchs quadrupled the Χρυσος, consequently their coins equalled four pounds.

The Romans estimated their money by weight, as the Greeks had done before, but they differed from that people in adopting silver for their coins, as they used copper, not in preference, but from necessity. The Roman pound was twelve ounces, consisting of four hundred and fifty-eight grains, though the money-ounce appears to have been four hundred and twenty troy grains, or five thousand and forty to the pound; this was the standard of copper. After silver was introduced, the ounce consisted of seven denarii, and gold was estimated by the scruple, the third part of a denarius, and the preceding weights. The sestertius, or half the third, a division of the number ten equally improper, and subsequently unusual, was chosen by the Romans as the principal estimate of their money. Servius Tullus introduced the practice of impressing figures on their copper or aes, which were those of pecus, or small cattle, from which circumstance the word pecunia was derived. This manner of distinguishing the coin was afterwards changed, and Janus on one side, and the prow of a galley on the other, became the marks of the

aes; this, with the triens, the quadrans, and sextans, impressed with the form of a vessel, were for a very long period the only medium; but five years before the first Punic war, circumstances had enabled the Romans to use silver, which they coined into denarii, bearing the head of the genius of Rome, with a helmet on one side, and on the other chariots drawn by two or four horses. The coin called victoriati received the figures of Victory and of Rome; and the sestertii generally had the protectress of the city, with Castor and Pollux.

The emperors usually ordered their own busts to be placed on their coins, except Augustus, who had Capricorn. Sixty-two years elapsed between the introduction of silver and that of gold, which occurred in the consulship of M. Livius Salinator. The as, derived from æs, brass, originally consisted of one pound weight, but the difficulties experienced during the first Punic war, compelled the public to reduce the value of the as, and to convert one into six ases. The success of Hannibal in the second contest, under the above term, produced still greater distress in the state, and another reduction in their value took place, when the as became but one ounce in weight; this was again reduced, by a law of Papyrius, to half an ounce, in which state it afterwards remained. The as, supposed by Kennet to be equal in value to a farthing and a half sterling, was the tenth part of the denarius, and the semi-æs, or semissis, was the half; the triens, as the word implies, was the third part of the as, and the quadrens the fourth, which was sometimes called triuncis and teruncius, as it weighed three ounces previous to the diminution of its value. The sextans, or sixth part, were not sufficiently numerous, and other divisions were made to answer the public convenience, such as the uncia, or twelfth part of the pound, the semi-uncia, and the sextula, or sixth part of an ounce; besides these there were the decussus, valued at ten ases, or one denarius; the vicessus, the value of two denarii; and the centussis was the largest coin of this metal, which was worth ten denarii, or one hundred ases, and may be said to be equivalent to six shillings and three-pence sterling.

The ancient denarius seems to have derived its name from the fact of its containing denos-æris or ases, or ten ases, though the weight varied; during the time of the Commonwealth it was the seventh part of an ounce. In that of Claudius the weight was precisely an attic-drachm; the former equalled eight-pence of our money, and the latter seven-pence, without entering into fractions in either case. Bigatus and quadrigatus were terms applied to the denarius, alluding to the bigæ or chariot with two horses impressed upon it, and the quadrigæ or chariot with four horses. Clodius introduced the victoriatus mentioned before, which was equal in value to the half of a denarius; it also bore the name of quinarius, from its containing the value of five ases. The celebrated sestertius, so called from sesquitertius, as consisting of two ases and a half, was half the victoriatus, and a fourth part of the denarius; exclusive of the above name, it was frequently called nummus and sestertius nummus, the value of which, in modern money, was extremely small, being little more than one penny. The obulus, or the sixth part of the denarius, was nearly of the same amount. The libella, the tenth of the denarius, equalled the as, or the supposed pound of copper or brass. The semi-libella explains itself, and the teruncius, or fortieth part of the denarius, was worth three ounces of the metal just mentioned.

The most remarkable Roman coins of gold were the aurei denarii, which were thus termed probably from their resemblance in size, or the similarity of the figures they bore on their surfaces to the denarii. Those coined under the Commonwealth weighed two silver denarii, and were worth seventeen shillings, one penny, and something more than a farthing sterling; the aureas, made after the change in the government, weighed two drachms, and was equal to no more than fifteen shillings of our money: during the time of the five first Cæsars they continued didrachmi; but the avarice of succeeding emperors induced them to reduce their weight considerably, which was restored by Domitian and Aurelian. It was under Philip that aurei of several sizes first appeared, those bear the bust of the genius of Rome on one side, and different objects on their reverses; the inelegance of the workmanship induces a supposition that they were made far from the seat of the arts. Mr. Pinkerton is inclined to think, the only alteration made in the Roman money by Aurelian was confined to the gold. At the commencement of the coinage of gold, the aureus was divided into the semissis of sixty sestertii; the tremissis, or third, of forty; another division of thirty; and a sixth or scrupulum of twenty; all of which were discon-

tinued, except the semissis or half of the aureus.

There is no part of the study of medals and coins more interesting than that of the class bearing portraits or busts of eminent persons, of those, the Macedonian are the first so distinguished; and it has been usual to begin the series with Alexander I., who reigned 500 years before the Christian era, or 2,308 years past; as his coin is the most ancient yet discovered. Next to the monarchs of Macedon, follow the kings and queens of Sicily, Caria, Cyprus, Heraclia and Pontus; to which succeed the kings of Egypt, Syria, the Cimmerian Bosphorus, Thrace, Bythinia, Parthia, Armenia, Damascus, Cappadocia, Paphlagonia, Pergamus, Galatia, Cilicia, Sparta, Pæonia, Epirus, Illyricum, Gaul, and the Alps, including a period of nearly 330 years, or from the time of Alexander the Great to the birth of Christ. According to Pinkerton, "the last series of ancient kings goes down to the fourth century, and includes some of Thrace, the Bosphorus, and Parthia; those of Commagene, Edossa, or Osrhsene, Mauritania, and Judæa." The above are the series of portraits of kings impressed on medals which have Greek characters; many are extant of eminent men, on coins of Greek origin.

The series of Roman emperors is complete, from Julius to the destruction of Rome by the Goths; after the latter period the execution of the heads became very barbarous. The Greek coins, bearing their kings, generally exhibit them with diadems, and no other ornament; and they invariably present the profile; those of Grecian cities of high antiquity, and Roman consular coins, on the contrary, have specimens of full faces; and there are instances of others, on which several busts have been introduced, particularly a beautiful gold one of Ptolemy Philadelphus, who introduced the heads of himself and Arsinoe on one side, and those of Ptolemy I. and Berenice, his parents, on the other. Two or more heads have been impressed, in some cases grouped and looking the same way, and in others they are placed face to face; the reverses on those having nothing remarkable to distinguish them; but the most rare and valuable coins contain three heads.

The vitta, or diadem, which resembles a modern riband tied round the head by a graceful knot, with the extremities floating in the air, is the distinctive emblem of a prince throughout the Greek medals; and it was imitated by some of the Roman magistrates; but the popular prejudice was so great against this badge of supreme authority, that their emperors thought proper to wear the radiated crown full 200 years before they ventured to resume it. "In the family of Constantine," says Pinkerton, "the diadem becomes common, though not with the ancient simplicity; being ornamented on either edge with a row of pearls and various other decorations." The crown, composed of branches of laurel, was an emblem of conquest when first adopted, as was the radiated crown a mark of deification originally; but each were afterwards assumed on their medals by ambitious and presumptuous emperors; in those of the lower empire, a hand is shewn holding the laurel above the head, which disposition of it was considered a mark of piety.

The rostral crown, made of gold, and resembling the prows of gallies connected, was exhibited by Agrippa on his coins, who also appears in the mural, assigned to those that distinguished themselves in first scaling the walls of a besieged city; the crown of oak branches, considered as a civic one, was adjudged to him who saved the life or lives of citizens; this frequently appeared on reverses, and particularly on the coins of Galba. Grecian princes adopted the crown of laurel, and added it to the diadem; and the kings of Parthia wore drapery folded round the head, and over their hair, curled in several ranges. The kings of Armenia had the tiara, the ancient eastern badge of imperial power; and Juba, the father, is shown in a conic cap set with pearls.

The vanity of the successors of Alexander the Great was conspicuous in each of their emblems, which induced them to take the lion's skin of Hercules; the horn, as a badge of their power, or probably as an intimation that they were the successors of the pretended son of Jupiter Ammon; and the wing, as a symbol of the rapidity of their military successes, or their descent from Mercury; the helmet is besides sometimes perceived on the heads of coins, particularly in the instances of Alexander and Constantine I.

The Grecian queens have the diadem, and the generality of those of Egypt the sceptre; in some cases placed near the upper part of the head, and in others transversely behind the neck; but the Roman empresses never had the diadem: the most remarkable part of the head-dress of the ladies of the latter nation, was the golden ornament called the

sphendona, worn on the crown of the head, and sufficiently large to be noticed on a medal; the hair was dressed as fashion dictated, and the emblematic figure of a crescent sometimes accompanied the bust of an empress.

When the toga is exhibited drawn over the head, the person so represented bore the pontificate or the augurship; the veil, the sign of consecration, is common on the coins of empresses; but those coins are rare and valuable on which emperors are presented in this manner. The more modern saints have now usurped the nimbus or glory with which ancient monarchs adorned their heads. "Havercamp gives a singular coin, which has upon the reverse of the common piece, with the head of Rome, VRBS-ROMA, in large brass, Constantine I. sitting amid victories, and genii, with a triple crown upon his head, for Europe, Asia, and Africa: legend SECVRITAS ROMÆ."

The most usual method of exhibiting portraits on ancient coins was by the bust; but there are instances of half lengths, and even more, of the person, in which case the hands are frequently introduced holding emblems of power.

The reverses of medals present an infinite variety of subjects; consequently they afford a proportionate degree of pleasure in the study of them; indeed there is scarcely any peculiarity in the manners, dresses, or religion of the anients, which they do not serve to illustrate and explain; the habits and symbols of their deities, the allegorical allusions common to their time, their religious ceremonies, the insignia of their magistrates, are given with so much truth, that, added to the historical events they were intended to record, it is impossible to feel indifferent when viewing them; exclusive of these, they furnish matter for curiosity, as sketches of various branches of natural history, by the representations of animals and plants.

A sufficient number of medals has been preserved, of each age, to observe the progress of taste in decorating them, and it appears that the most ancient are without any other mark on the reverse, beyond the indenting of the instrument on which the metal was supported when impressing the obverse; those are four points calculated to secure it firmly: the deformity thus occasioned did not pass unnoticed by the artist and his employer, and invention suggested the insertion of small fish or animals between the points, which were gradually improved upon, till the difficulty was entirely removed, and the figures became beautiful, correct, and highly-finished performances, that will bear critical examination, even furnishing studies for the proportions and muscles of men and animals. The reverses of some Greek medals of great antiquity are concave, and the obverses in a few instances are convex, and the time at which the engravers of their dies became adepts in their art, and capable of making a complete reverse, was about 500 years before Christ. The Romans, sensible of their inferiority to the Greeks in this particular, had the good sense to invite skilful persons to Rome, where they executed the best Roman medals, and taught the artists of that nation to emulate their excellence. None of the above, or Etruscan coins, have been discovered, which are globular, or with an indented reverse similar to those already mentioned; the earliest Greek specimens are universally of silver, whereas the Roman are of copper, cast in moulds, and large, in which they greatly differ from the diminutive size of the Greek.

The Romans seem at first to have been very deficient in composing their reverses, and by no means profited by the rich examples before them: it is, indeed, difficult to account for the constant uniformity and repetition of cars, and prows of gallies, that prevailed till very nearly the Christian era, after which period a variety occurs; and during the reign of the emperors they made ample amends for their previous neglect of this side of the medal. Mr. Pinkerton observes very justly, "that the medallist much values those which have a number of figures, as the puellæ faustinianæ of Faustina, a gold coin no larger than a sixpence, which has twelve figures; that of Trajan, regna adsignata, has four; the congiarium of Nerva, five; the allocution of Trajan, seven; of Hadrian, ten; of Probus, twelve." There was a felicity of thought, and a happy mode of conveying a compliment, adopted by those who struck medals at the time now under notice, which was accomplished by giving the representation of a virtue, and calling it that of the person commemorated; in this particular, the Romans differed greatly from the Greeks; the latter people uniformly pointed out the effigies of their gods and genii by their generally received emblems; but the former inscribed their names. It is entirely useless to particularize the deities and their insignia;

but, in order to facilitate the study of medals, it may be proper to mention some of the symbols which are not commonly known; branches of plants issuing from vases, for instance, imply a reference to religious games; the serpent springing from a coffer denotes the mystic rites of Bacchus; the anchor on medals infers that they are Seleucian, and struck at Antioch; the tripod was placed, by the Syrian princes, covered and uncovered, under the figures of their deities; to which may be added others, in the words of Mr. Pinkerton: "the flowers of pomegranates, for Rhodes; owl, for Athens; pegasus, for Corinth; wolf's head, for Argos; bull's head, for Bœotia; minotaur's head, and the labyrinth, for Crete," &c. &c. Were we to pursue this part of the subject, it would lead to an incredible length of investigation, and it may be doubted whether many mistakes might not be created through the obvious obscurity involving it.

The legends on coins and medals are of too much importance to require a recommendation of their study; the earliest coins of Grecian cities have either the initials, or their names at length; and those of the princes of that country, their names, initials, or monograms. The imperial medals of Greece and Rome are distinguished by methods far more explanatory, as they have words round the face, the reverse, and even in the centre of the latter in some cases. Medallists have divided the inscriptions into three terms, suited to the place of the words; when they encircle the margin they are called the legend; when they occupy the centre of the medal they are called the inscription: and when they are separated from the figure by a line near the bottom, they are on the exergue. The varieties and abundance of legends, &c. precludes a possibility of entering into their merits and peculiarities; some, being merely explanatory, cannot be subject either to censure or criticism; others impute virtues, and convey compliments well deserved; but it may justly be doubted, whether the majority do not speak every language except that of truth. One specimen may serve to convince the most incredulous on this head: Julia, the consort of Severus, was termed MAT. AVGG. MAT. SENAT. MAT. PAT., or, the parent of Augustus, the senate, and of her country; but Tiberius became blasphemous, as far as blasphemy could be said to exist in the heathen mythology, by calling himself the *divi filius*. However wanting these legends and inscriptions might be in verity, they must be allowed the merit of beautiful simplicity in their construction, and the most elegant compression.

We have hitherto treated the subject of coins and medals conjointly, which was in a great degree unavoidable, through the similarity of each to the other; for though a coin may be said to be merely intended as a circulating medium, calculated to prevent the difficulties attending the bartering of commodities, yet it has been customary from time immemorial to impress figures on the pieces of metal used for this purpose, of equal import with those stamped on medals intended solely as historical records, or as adulatory offerings to supreme power.

Medallions were made of dimensions far too large for circulation as money, which was necessary in order to give due effect to the design, and to render it intelligible at first view; some were struck as patterns of proposed coins; others were issued at the commencement of a new reign, and on remarkable occasions; and in some instances they may have been the effects of caprice of men in high authority; and, in a few cases, of gratitude. It is usual to consider as medals, all those Roman pieces which exceed the denarius aureus in size; those of silver larger than the denarius; and those of brass, which are of greater diameter than the sestertius; but Mr. Pinkerton is of opinion, "that the gold medallions, weighing two, three, or four aurei only, passed in currency, as the Greek gold didrachms, tridrachms, or tetradrachms, according to their size. The like may be said of the silver, which are commonly of the value of a Greek tetradrachm: they, I have little doubt, went in currency for four denarii." The brass medallions have the greatest variety of devices on their surfaces, and are executed in a style of superior excellence. Greek pieces of the above description, made before the Roman empire, are extremely rare; but Greek medallions of Roman emperors are far more numerous than the Roman. After the reign of Hadrian, the medallions of that country are seldom found to be of fine workmanship, yet they are invaluable for their rarity, variety, and the intelligence of their devices; these circumstances render them very high priced.

Besides the superior class of medallions, there are others, particularly of a size between the first and second brass, which the Italians call medaglioncini, and Mr. Pinkerton, medalets, and tokens, and

counters, each proceeding from a variety of causes occurring in the Roman dominions. The contorniatii, another kind, are so termed from the hollow circle round them; those are large as medallions, thin, and of inferior execution, and have afforded much latitude for conjecture as to the purpose for which they were intended.

We are under the necessity of dwelling on the foreign coins and medals of antiquity to a considerable extent, that the subject might be fully understood, as we are wholly indebted to the ancients for the invention of money, and even for our designs in many instances. It appears, from the account of Britain written by Cæsar, that the inhabitants at that period had brass and iron money, the use and coinage of which was probably derived from our Gallic neighbours. Cunobelin, to whom many ancient coins found in England have been ascribed, was educated in the court of Augustus, and King of the Trinobantes: those are supposed to be the only extant, purely English, of which there is an admirable collection in our national museum; the legends of them are generally CVNO, and TASCIA, and CAMV; the first seems to apply to Cunobelin, the second has never been explained, and the third may be Camudolanum; the devices are a horse, an ear of wheat, and a bust, accompanied by the abbreviation *Cuno*, on one side, with a variety of emblems on the other, and *Camu*.

English medals, intended entirely as such, were never struck in the ancient periods of our history, and the first known to have been made by order of an Englishman, and stamped on brass, most probably in Italy, was one found in Knaresborough forest, in the seventeenth century, which bears a bust with the legend IO. KENDAL RHODI TVRCVPELLERIVS. MCCCCLXXX. on the obverse, and on the reverse his family arms, and TEMPORE OBSIDIONIS TVRCORVM. MCCCCLXXX. It is singular, that the vast variety of important events which have occurred in England, should have passed away without suggesting this method of perpetuating their remembrance, and that an example should have been set to our monarchs by a knight of Rhodes, who was more affected by the raising of the siege of that island by the Turks, than Edward III. was by his deeds in France. Henry VIII., one of the least worthy of the kings of England, caused a medal to be struck in 1545, which is of considerable diameter, and of gold: the legends of this second British medal are three in number, and are inserted one within the other on the obverse, inclosing his head and face in front; the reverse has two inscriptions, in the Hebrew and Greek languages, which signify his being the defender of the faith, head of the church, &c. The first coronation medal was that made by order of Edward VI., the son and successor of Henry, whose medal just described served in every respect for a model. Very little can be said in commendation of the execution of these pieces; neither are those of Elizabeth much better, with the exception of one or two. Though earlier in point of time, Philip and Mary were more fortunate in the selection of their artists, particularly Trozzo, who did two in silver for those monarchs, of high relief. Richard Shelly, Prior of the order of St. John of Jerusalem, in England, one of the last who presided at Clerkenwell, caused one to be struck in the reign last mentioned, which deserves praise.

Charles I. a good judge of the arts, exceeded his father, James I. in the excellence of his medals; that dated 1636, representing the King and Henrietta Maria, is finely executed, particularly the heads. "The reverse," observes Mr. Pinkerton, "represents Justice and Peace kissing, awkwardly enough." "The tout ensemble of the piece, however, is bad, and quite unlike the antique, the standard of perfection in this way, owing to the field of the medal not being above a line thick, while the relievos are a full half inch in thickness: whereas, in the best and boldest ancient medallions, the edge of the piece is two or three lines thick, where the relief is three or four. A hollowness is, indeed, given in the ancient to the inner field around the relief, both to give more elevation and boldness, and that the edge may something protect the subjects of the field." The medals of Charles would, without doubt, have exceeded all others made by his predecessors, in a very great proportion, had his politics been more successful: still they deserve approbation; though Simon, employed by the Commonwealth and Cromwell, soon after his death, surpassed them. Had this celebrated artist received the patronage of the dethroned monarch, in a state of peace, the correctness of his judgment and experience must have produced most superb pieces, which would probably have rivalled those of the Greeks when in the zenith of their fame.

Charles II. had several good medals, particularly the three struck on his leaving Holland, at the Restoration, and at his Coronation. Catherine of Portugal,

his consort, decorates some, one of which has her head, and on the reverse *Pietate Insignis*. Mr. Walpole communicated to Mr. Pinkerton, from Vertue's manuscripts, an account of a rare and singular medal, made by command of this licentious monarch, representing the Duchess of Portsmouth on the obverse, and Cupid on a wool-pack on the reverse; besides the above there are the *Favente Deo;* the *Pro talibus ausis;* and the *Felicitas Britanniæ.* The same author adds, "The short reign of James II. has several medals. The most remarkable are the *Nemo me impune lacesset;* that with his queen, *Fortes Radii sed Benigni;* those on the Pretender's birth, *Felicitas Publica.* Others have *Orbata luce lucidum obscurat; Magnis interdum parva nocent; Pro glandibus Aurea poma.*"

The Pretender, though unsuccessful in his attempts to regain the throne of his fore-fathers, and an exile to the hour of his death, was still so much of an Englishman as to require notice in this article, particularly as his history is a collateral branch of that of England: this Prince caused a medal to be struck by the Papal medallist, Hamerani, on the occasion of his intended consort's escape from the arrest procured by the English minister at Vienna, and which took place in the Tyrol, on her way to the Pretender. The lady was represented on the obverse by her bust, with the legend *Clementina M. Britan. Fr. & Hib. Regina;* and on the reverse she is shewn seated in a chariot, giving the rein to two horses which are drawing it at full speed, the legend *Fortunam Causamque sequor;* and on the exergue, *Deceptis Custodibus,* MDCCXIX. Another medal was struck by him on the birth of his eldest son; this exhibits the busts of the Prince and Princess, with the legend *Jacob. III. R. Clementina R.*; and the reverse has the lady supporting the child on her left arm, which rests on a pillar, an emblem of constancy, the right hand extended points to a globe, presenting England, Scotland, and Ireland, with the legend *Providentia Obstetrix;* the exergue, *Carolo Princ. Valliæ. Nat. Die ultima, A.* M.DCC.XX.

To return from this digression to the time of James II. That weak and unpopular king either caused or permitted malignant medals to be circulated, satirizing Monmouth's rebellion, and exulting in his death; the legends on those were *Parum successit feci sedulo; superi risere; Caput inter nubila; Providentia improvidentia, &c.* The reign of William III. was productive of a series of most uncommon events, each of which made admirable subjects for medals; indeed his birth was celebrated by the striking of one, representing his mother on the obverse, and himself in childhood on the reverse. After his accession to the throne of England, he had his own bust and that of Queen Mary, almost universally, placed on the obverses of his medals, particularly in those known by the following legends: the *Ataius par nobile; Atarum pro libertate; Nec Lex est justior ulla; Nisi tu quis temperit ignes, &c.*: others, which have the king's bust alone, are the *Apparuit et dissipavit;* the *Gul. Nass. in Torbay, &c.;* the *Victis ac fugatis Hibernis;* the *Imperium pelagi nobis;* the *Nunquam impune lacessitus, &c.*

Equally fortunate and prolific in great events was the reign of Anne. This Queen, illustrious in virtue, perpetuated the victories achieved by her armies, under the incomparable Duke of Marlborough, in a regular series of medals; but here we are compelled to cease. Although the subsequent history of this country furnishes repeated occasions for a rich display of medallions, they have nearly been passed unnoticed in this particular; and most of the medals we possess, of modern execution, have been struck by private persons, sometimes to honour the memory of worthy men, but generally to procure present emolument: in the latter class may be included, Dassier, who engraved and struck a series of all the kings of England, then thirty-six in number, which were executed with great spirit, and are of copper. Dassier was a native of Geneva, and made this addition to English medals about 1740.

The reader will perceive that we have been principally indebted to Mr. Pinkerton's excellent essay on medals for the preceding facts, nor do we hesitate to acknowledge, that we shall be equally so for the following sketch of the history of British coins, except some few particulars towards the close of the article. That gentleman observes, the heptarchic coins were of two descriptions; one, the silver skeata, or penny, and the copper, or billon styca; the latter was confined to Northumbria, and in the later period of that kingdom the size was diminutive, and the value not more than half a farthing of our money; it is the silver penny therefore which is to be considered as the general coin of the heptarchy, for neither gold or any other kind of silver was issued for a long time after. The admirers of

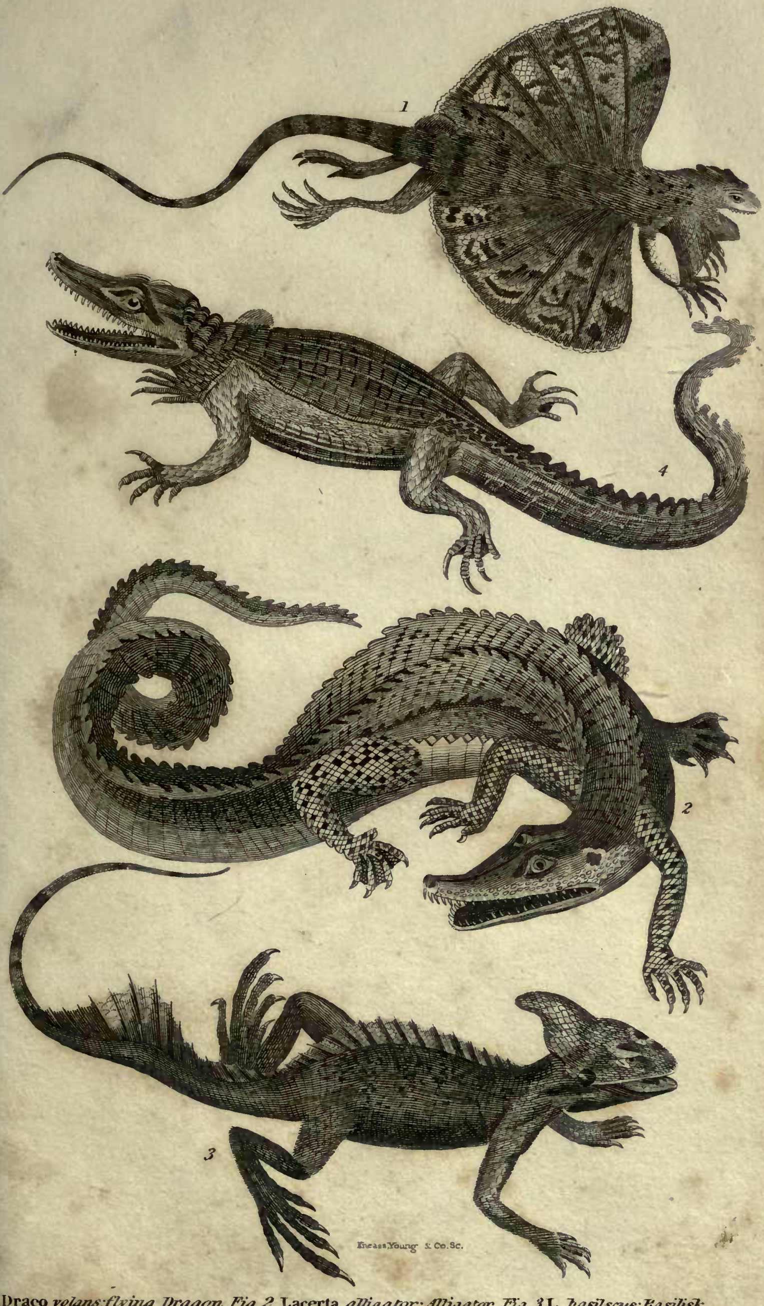
this study are indebted to Dr. Combe for their present knowledge of the skeata, who caused several of them to be engraved; the most ancient have figures of serpents impressed on them, sometimes with the addition of one or two letters, but legends were subsequently introduced: it is obvious, from the symbols, they all belong to the period when the Pagan mythology prevailed. The heptarchic pennies do not occur till after the year 700, though there are skeatas of Ethelbert I. King of Kent, between 560 and 616; and of Egbert, monarch of the same district, anno 664. It is by no means necessary to trace all the coins of the heptarchy, it will be sufficient to say, that those of the principal sovereigns exist, almost in a complete series, from Egbert in 832 to Edgar 959; the generality of them have badly executed portraits on the obverse, but the reverses are far more interesting, presenting elevations of cathedrals and other structures, particularly York Minster, on one of Edward, senior, A. D. 900.

The coins of Anlaf. King of Northumbria, bear a raven; Egbert's have the legend *Saxonum* instead of *Anglorum;* and the pennies of Athelstan have *Rex tot. Brit.* Exclusive of these royal coins, there were others purely ecclesiastic, which are extant between 804 and 889, and were struck by several archbishops of Canterbury. Except on the money of Alfred and Edward I. that has towns added, only the names of the moneyers were introduced; from the time of Athelstan, anno 925, the conjunction became general. Neglect or policy prevented William of Normandy from making any alteration in the English penny, and in some instances he adopted the same reverses used by his predecessor, Harold the usurper. This penny possessed many intrinsic qualities, which rendered it more acceptable to the inhabitants of the northern kingdoms, Italy and France, than their own; hence it may be concluded, that the commerce of England was extensive even at that remote period, particularly as the first mentioned nations had scarcely any other medium. It is a singular circumstance, and much to the credit of our native land, that it furnishes a complete series of pennies from the reign of Egbert to the present moment, with the exception of those of John and Richard I. whose coins were in the first case Irish, and in the last French; if these monarchs had any struck in England, they have not yet been discovered: in this particular we exceed every nation on the globe. The earliest pennies weigh $22\frac{1}{2}$ grains, troy; at the close of the reign of Edward III. they weigh 18 grains, they then fell to 15; and in that of Edward IV. they are 12; Edward VI. reduced the penny to 8 grains; and Elizabeth to $7\frac{23}{31}$. The next coins of antiquity are the halfpennies and farthings, of silver, which were first made permanently by order of Edward I. and continued till the revolution in the time of Charles I.; but the farthings were discontinued after the death of Edward VI. Those were succeeded by the groat piece, introduced by Edward III. and the testoon, or shilling, by Henry VII.; the former term is said to be derived from teste, or tete, the head of the king impressed upon it; the latter evidently comes from the German word schelling. The crown piece, of silver, was first issued by Henry VIII.; and Elizabeth coined three-halfpenny and three-farthing pieces, which were not continued by her successors.

Henry VIII. was the first of our monarchs who ventured to debase the money of his realm; and Mr. Pinkerton justly exclaims "it was a debasement indeed! for it extended to $66\frac{2}{3}$ per cent:" that issued by him, bearing his profile, is of the ancient standard; but that with his portrait in front, is of the description alluded to. Edward VI. who was the last monarch that had his bust thus represented, exactly reversed his father's example, as his coin, with the side face, is bad, and the full face good. The base coin of this king is the first which is dated; the silver coin was restored to the original standard in 1552; and since 1601, 18 pennyweights of alloy has been used in the pound weight.

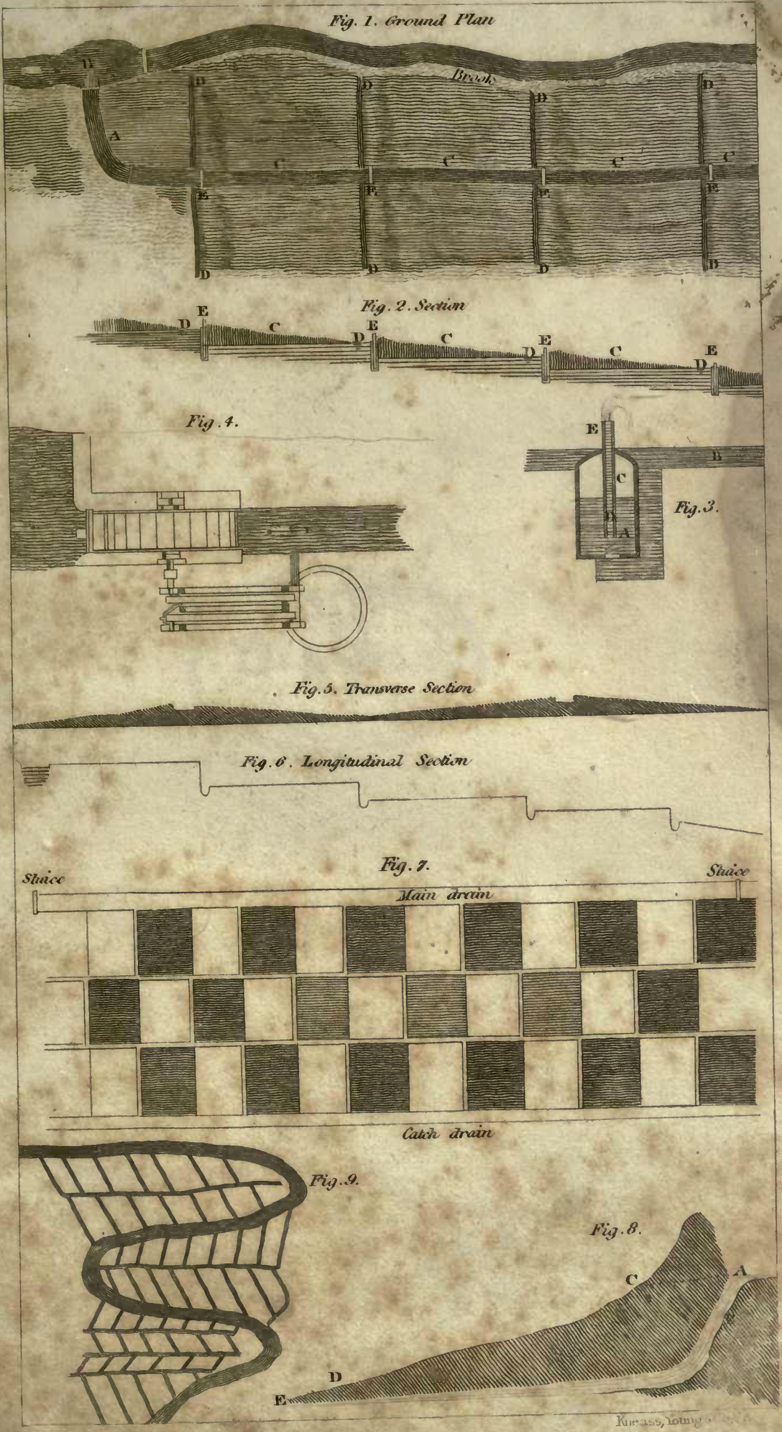
Henry III. introduced the coinage of gold: his attempt appears, however, to have been unsuccessful, as only two specimens have reached our time, and are called the gold penny; they are larger than that of silver, and tolerably executed: it is to Edward III. therefore, we are indebted for the establishment of the system still prevailing, which the last named prince commenced in 1344 with the florens, then worth six shillings, but now greatly increased in value, and thus called from Florence, where the best gold was coined at that period. Half and quarter florens were made at the same time, though none of the former have descended to us. The floren being found inconvenient, from the value not according

Fig. 1. Lemur catta Ring tailed Macauco.
—— 2. —— ecaudatus tailess Macauco.
—— 3. Lepus cuniculus Domestic Rabbit.
—— 4. —— timidus Male & female Hare.
—— 5. Manis pentadactyla short tailed Manis.



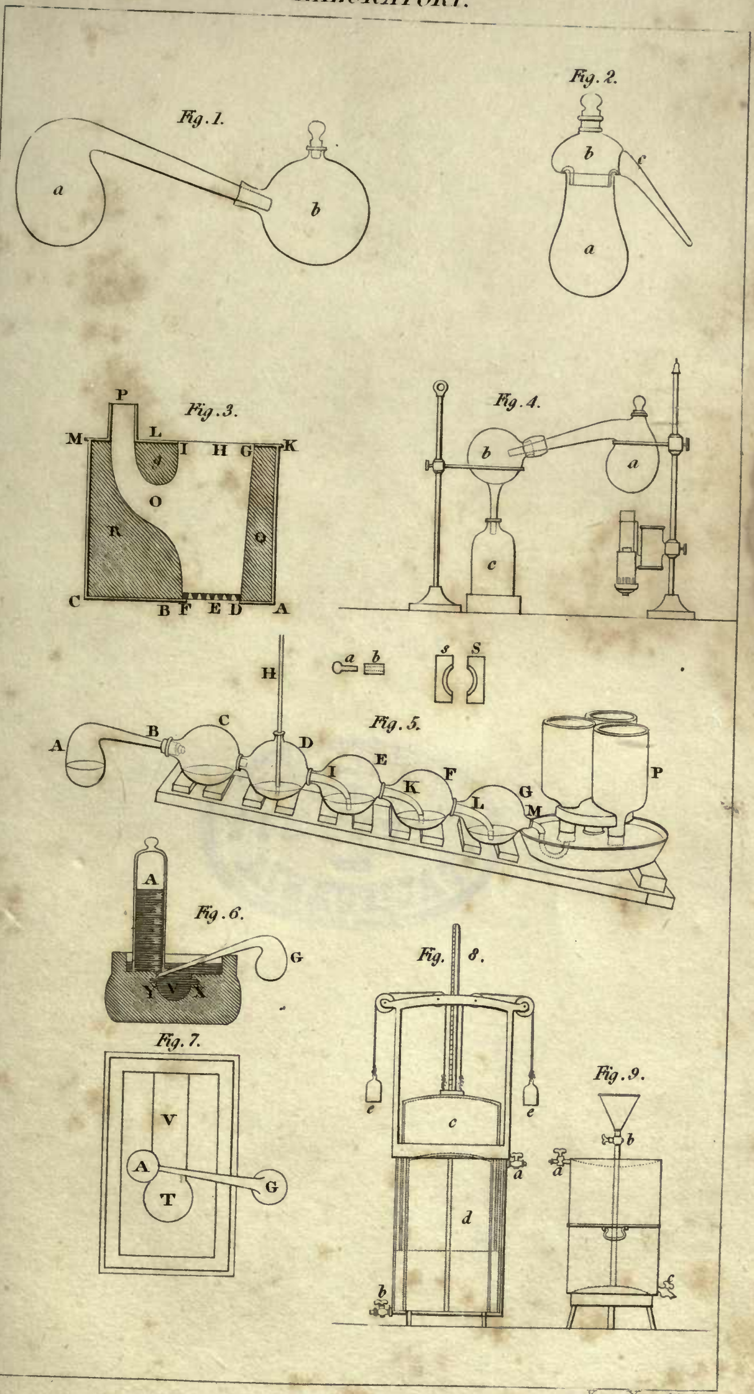
1. Draco *volans: flying Dragon.* *Fig. 2.* Lacerta *alligator: Alligator.* *Fig. 3.* L. *basilscus: Basilisk.*
. L. *crocodilus: Crocodile.*

IRRIGATION.



Kneass, Young

LABORATORY.



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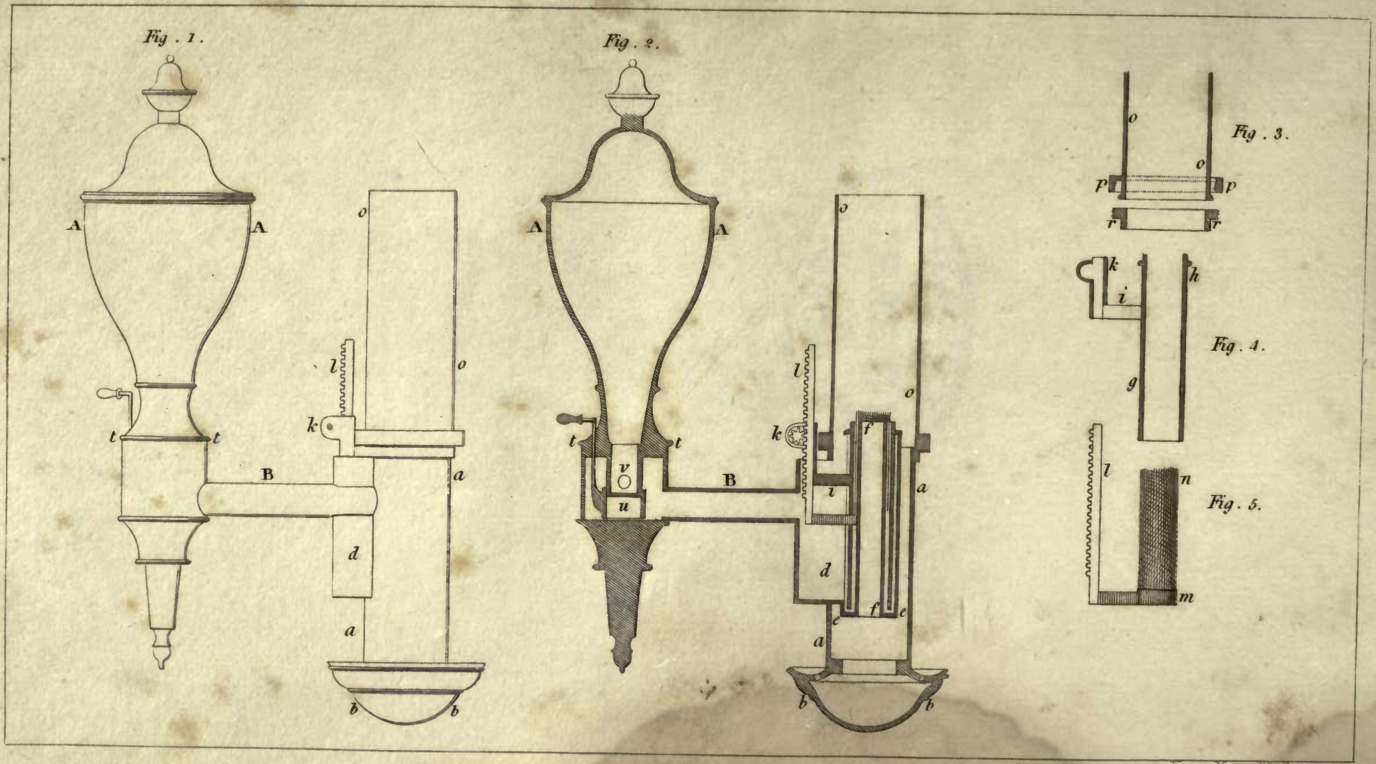
Argand Lamp.



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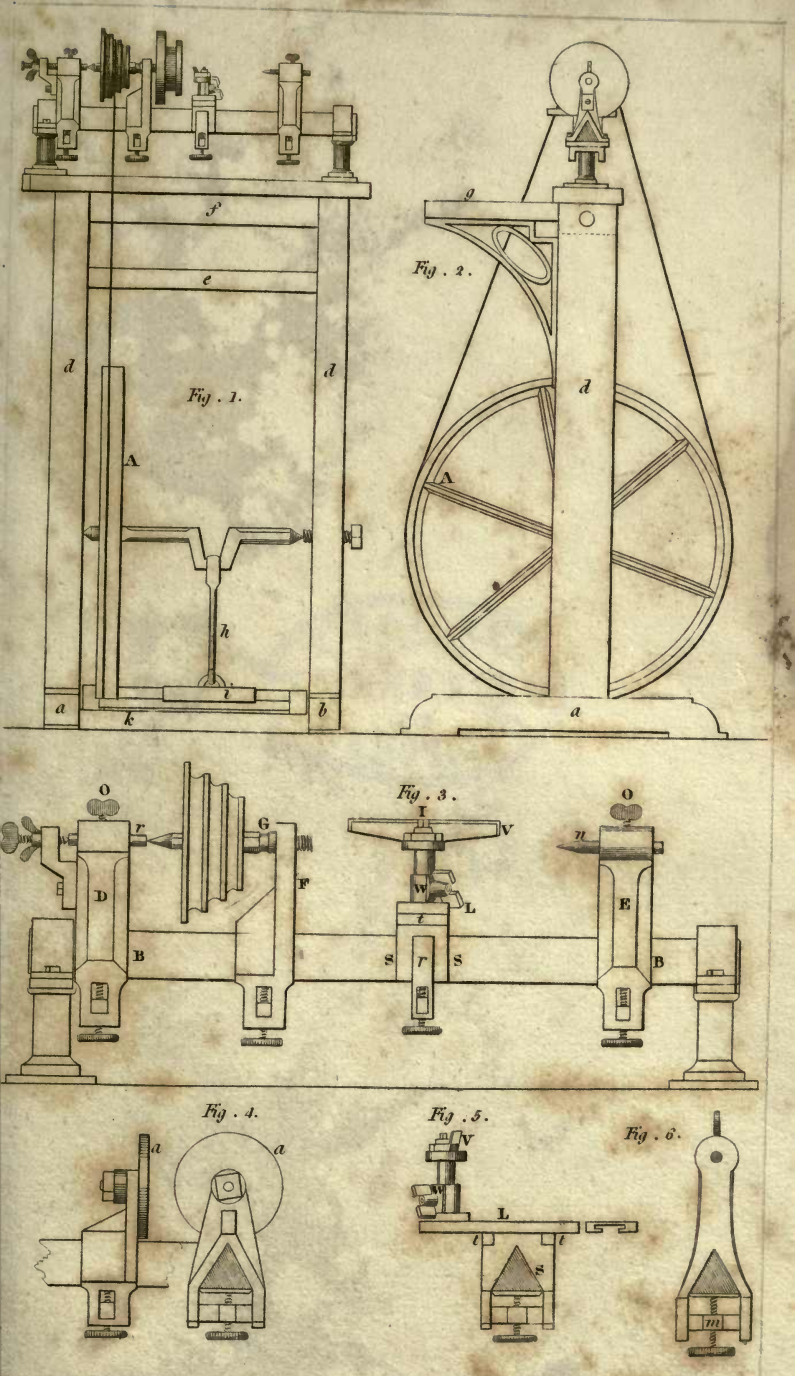
LATHE.



SPIRIT LEVEL made by Ramsden.

Section *Fig. 1.*

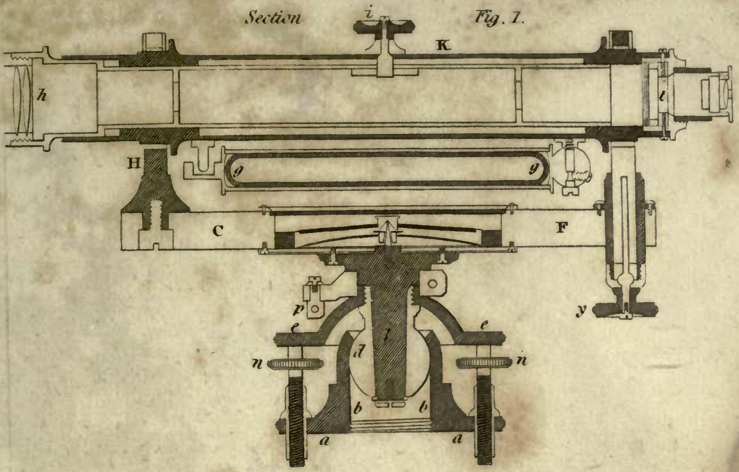
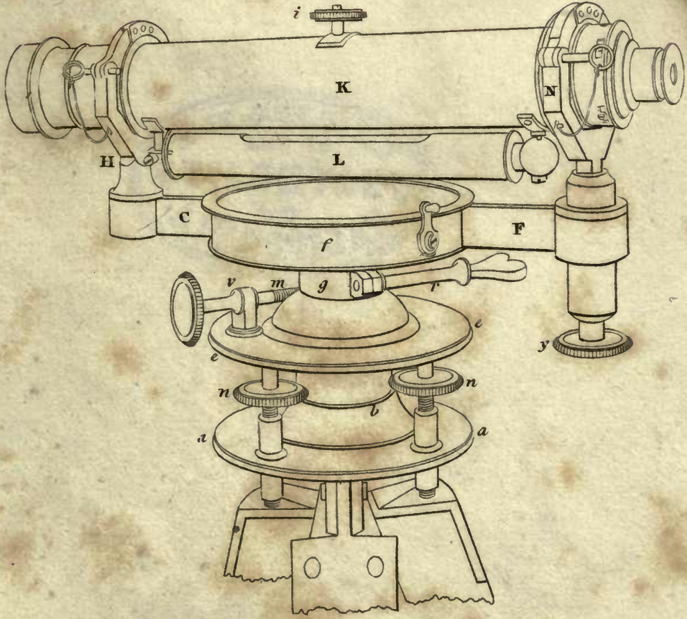


Fig. 2.



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MACHINE ELECTRIC.

Fig. 3.

Fig. 2.

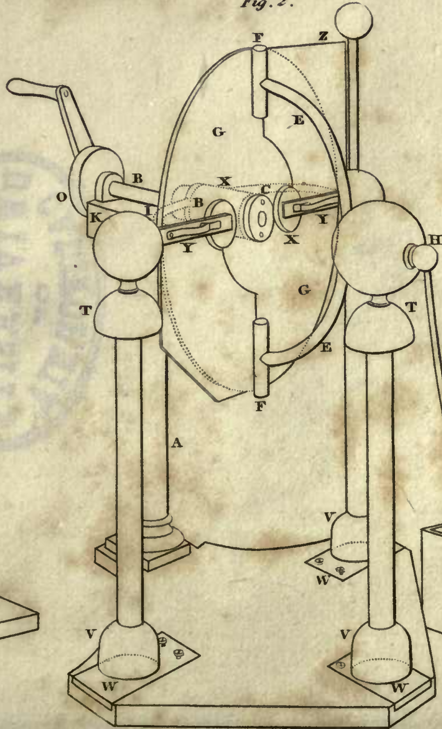


Fig. 4.

Fig. 1.

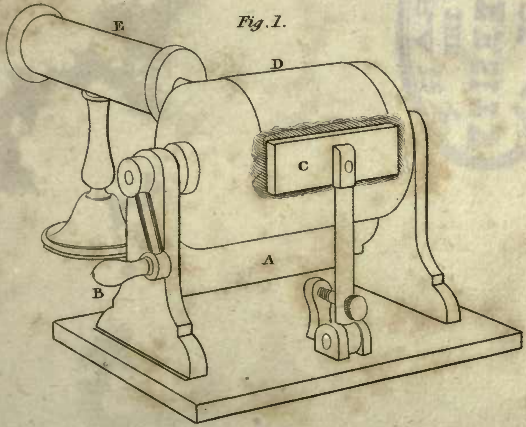


Fig. 5.

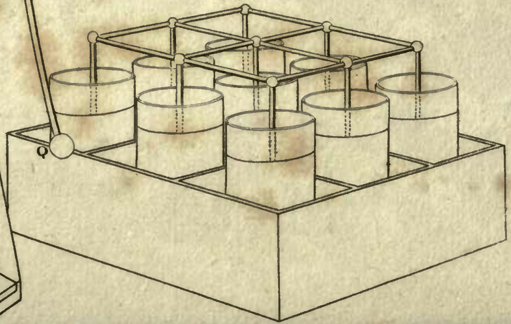


Fig. 1.

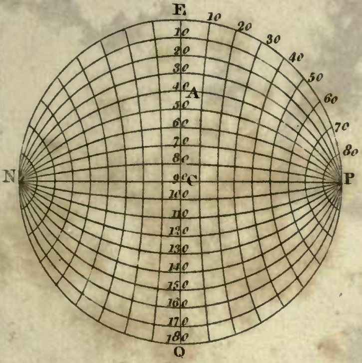
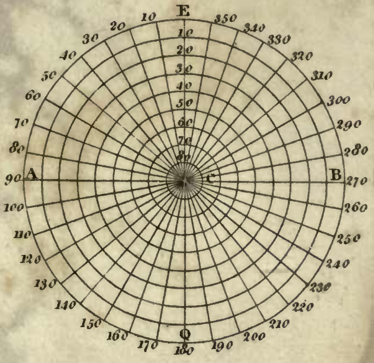


Fig. 2.



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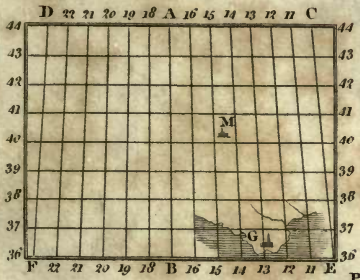

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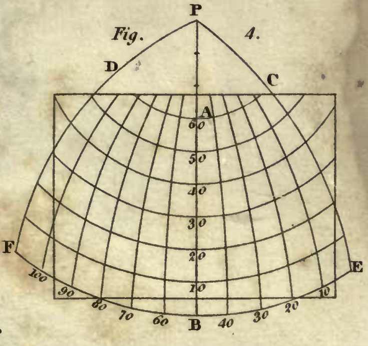

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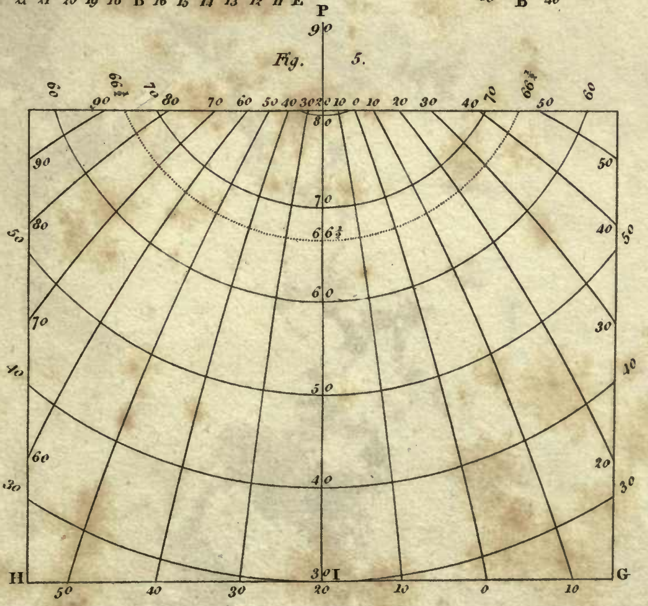

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Lever

Fig. 1.

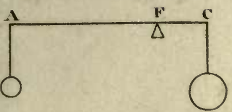
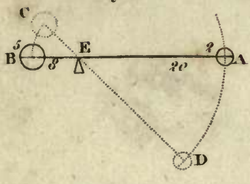


Fig. 2.



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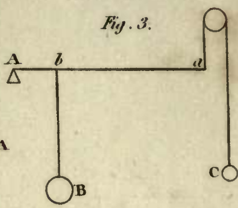
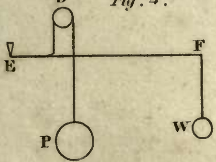


Fig. 4.



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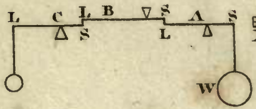

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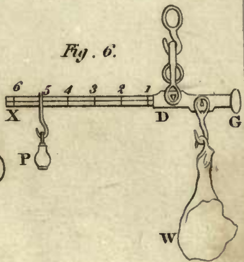


Wheel & Axle

Fig. 7.

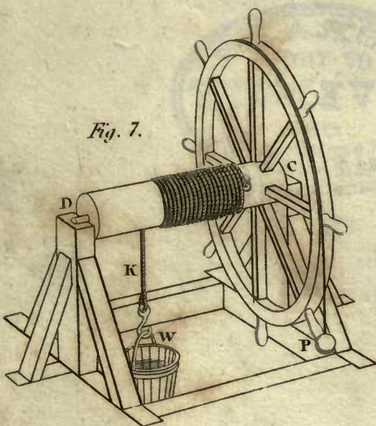
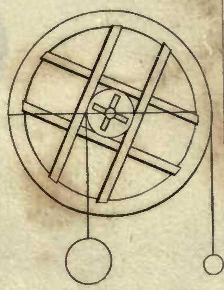


Fig. 8.



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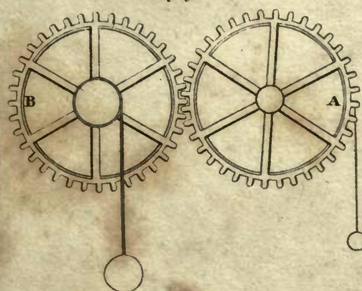

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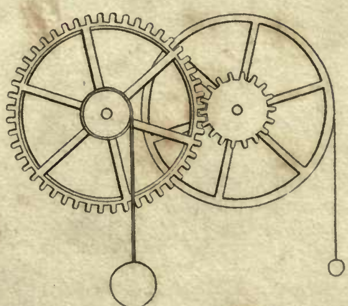

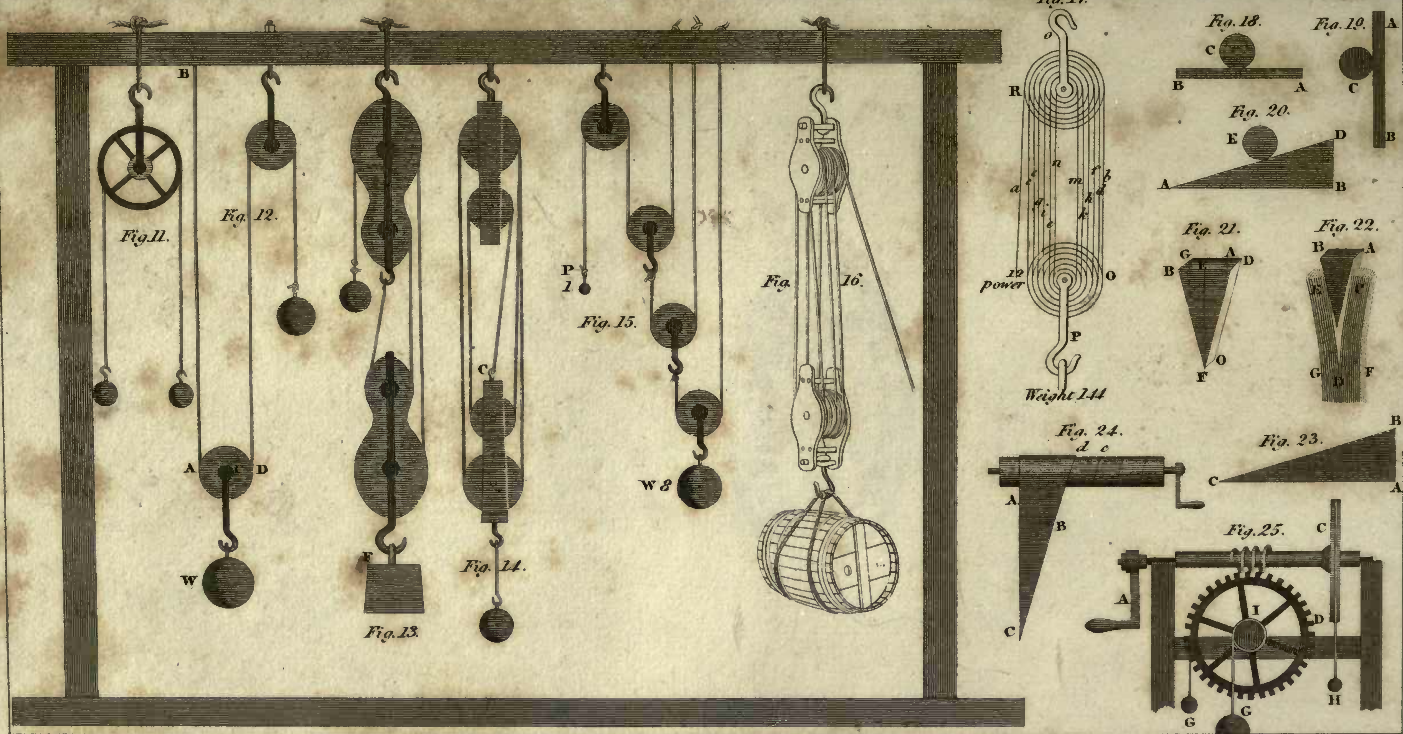

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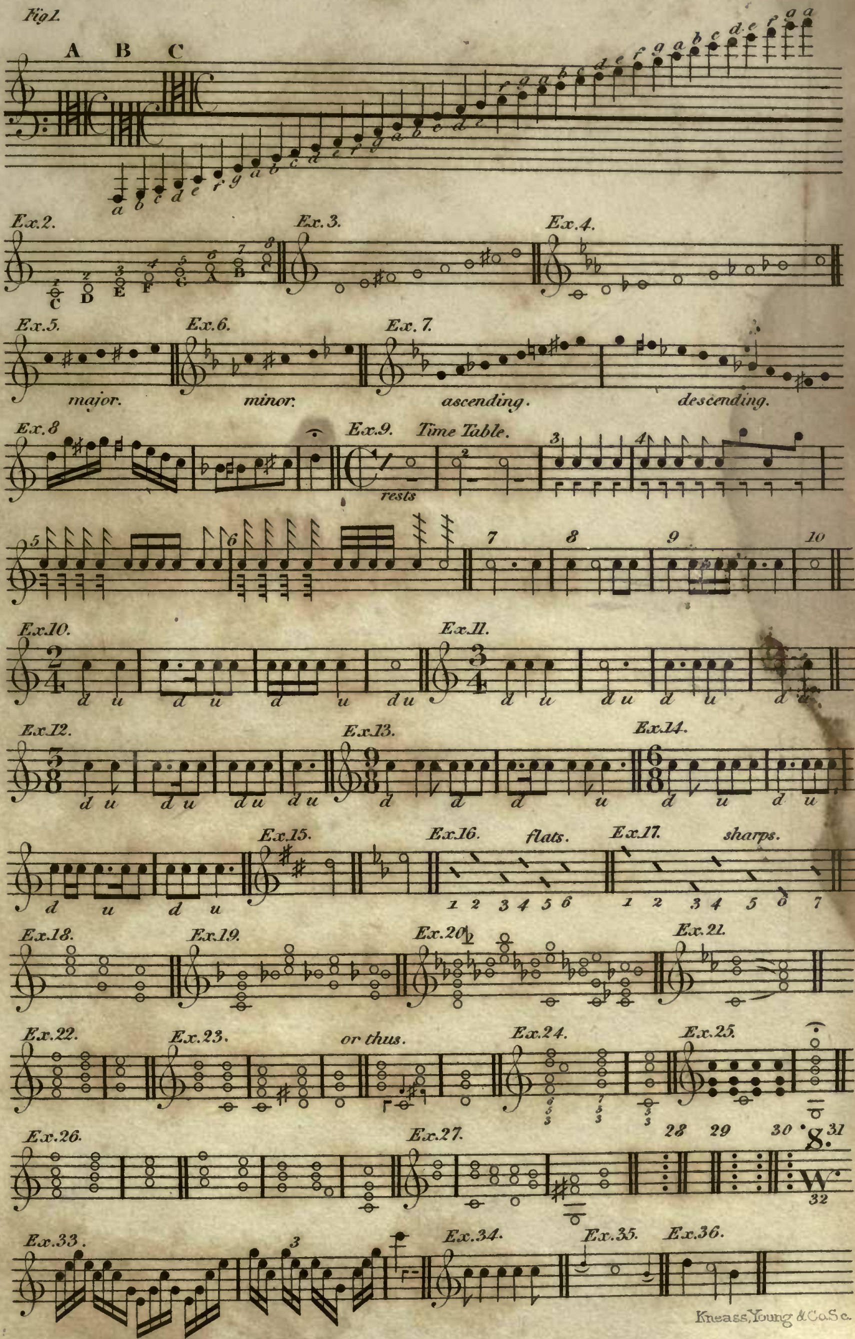
MUSIC.



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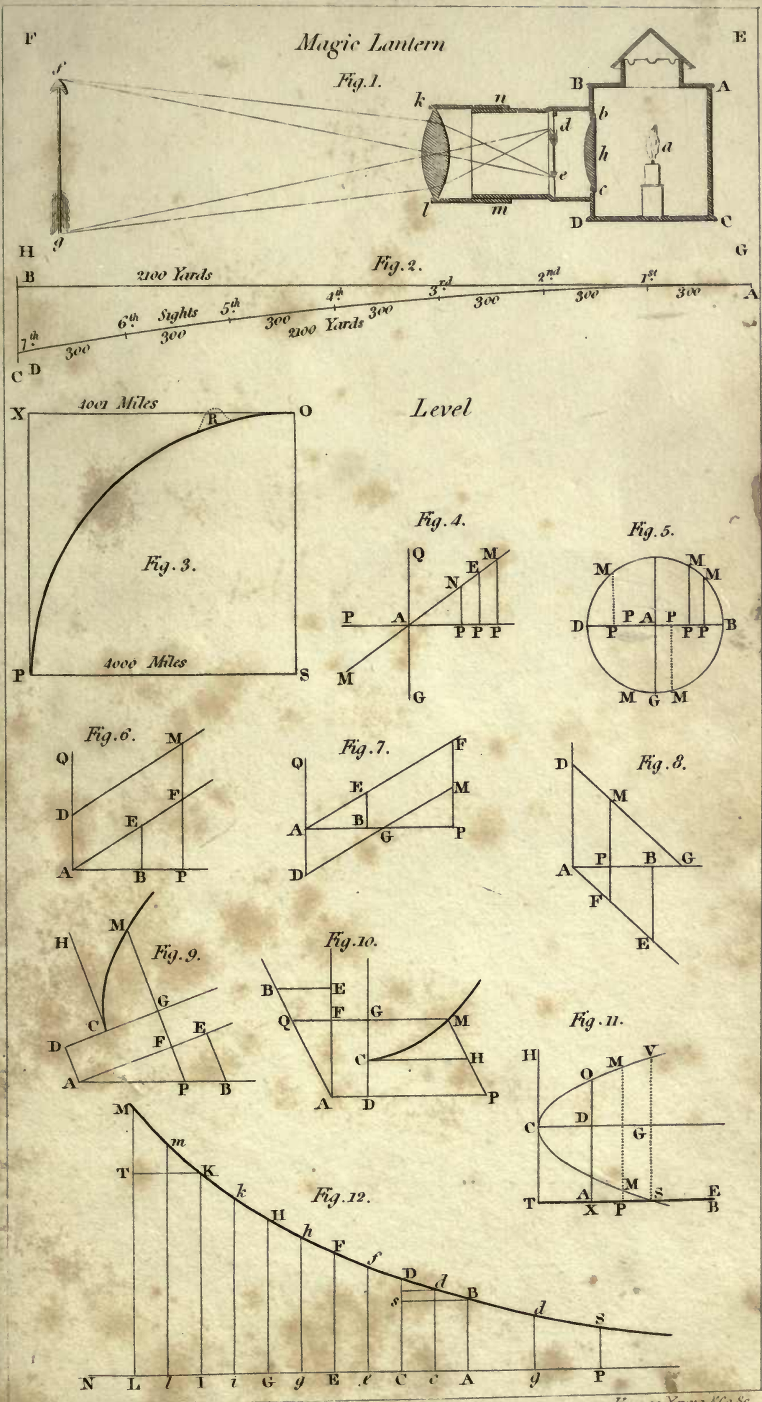

Magic Lantern
Fig. 1.
Fig. 2.
2100 Yards
7th. 6th. Sights 5th. 4th. 3rd. 2nd. 1st.
300
2100 Yards
4001 Miles
Level
Fig. 3.
4000 Miles
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10.
Fig. 11.
Fig. 12.

Fig. 1.

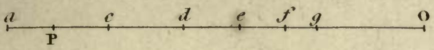


Fig. 2.

Fig. 3.

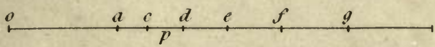
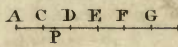


Fig. 4.



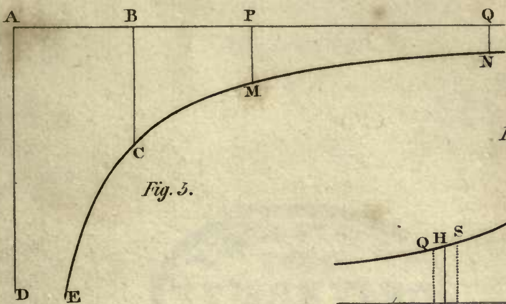


Fig. 5.

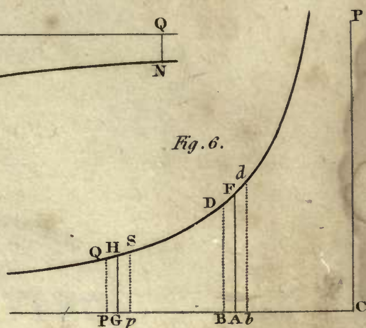
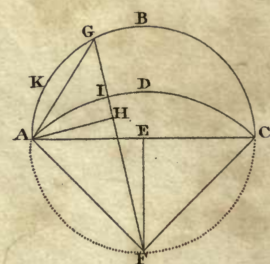


Fig. 6.

Fig. 7.



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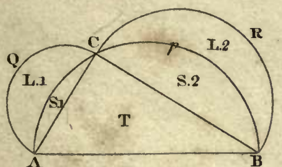

Fig. 9.

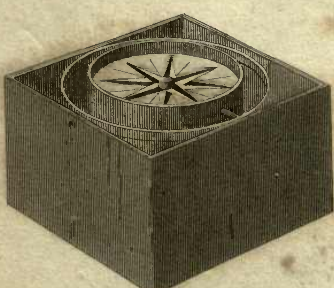

Fig. 10.